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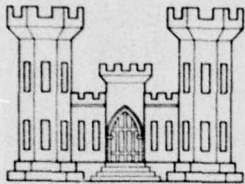
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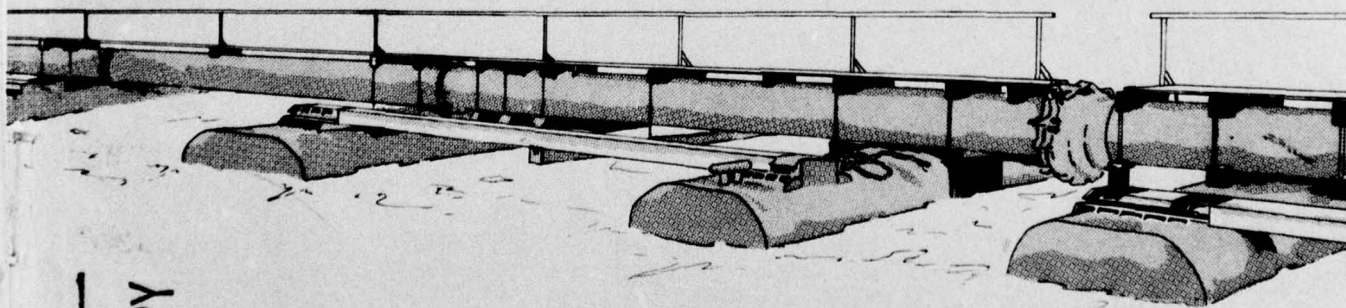
RECENT AND PLANNED MARSH ESTABLISHMENT WORK THROUGHOUT THE CONTIGUOUS UNITED STATES A SURVEY AND BASIC GUIDELINES

by

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April 1977
Final Report

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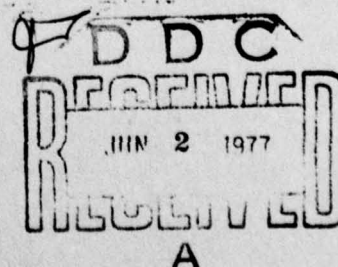


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(DMRP Work Unit 4A25)

Monitored by Environmental Effects Laboratory
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29 April 1977

SUBJECT: Transmittal of Contract Report D-77-3

TO: All Report Recipients

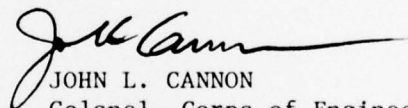
1. The contract report transmitted herewith represents the results of one of a series of research efforts (work units) undertaken as part of Task 4A (Marsh Development) of the Corps of Engineers' Dredged Material Research Program (DMRP). Task 4A is part of the Habitat Development Project, which has as one of its objectives the development of environmentally and economically feasible disposal alternatives compatible with the Corps' resource development directive.
2. Marsh development, one of several disposal alternatives involving habitat development, is under intensive laboratory and field investigation within the DMRP. Considerable research involving marsh creation has been conducted by other elements of the Corps of Engineers, Federal and State agencies, and several universities and private firms. The purpose of this report was to identify those marsh development studies not being conducted by the DMRP and to categorize these projects on the basis of location, size, species composition, status, and results.
3. The information contained in this report was obtained by identifying those investigators recently involved in marsh creation in the United States and interviewing them in person or by telephone or letter. A standardized information request was used. One hundred and five separate projects were identified. The contractor, Dr. E. W. Garbisch, compiled the findings of this survey and has presented a synthesis in both tabular and expository form. Responses received to the questionnaire are appended in microfiche.
4. The reader should note that many of the data presented were derived from observations and are not necessarily the result of planned experimental tests. Examples of subjects that are not completely understood include the need for fertilization and the relative desirability of seeding versus sprigging. Consequently, the application of the findings of this study must be tempered with judgement based on local experience or conditions.

WESYV

29 April 1977

SUBJECT: Transmittal of Contract Report D-77-3

5. This work unit (4A25) provides a current summary and synthesis of non-DMRP marsh development research. Data from these studies will be combined with the findings of DMRP research including the following: identification of relevant criteria and survey of potential application sites for artificial habitat creation (4A01); state-of-the-art survey and evaluation of marsh plant establishment techniques (4A03); productivity of minor marsh grass species (4A04 and 4A20); modeling of ecological succession and production in estuarine marshes (4A05); concept development and economic and environmental compatibility analyses of underwater and/or floating dredged material retaining and protective structures (4A07); development of guidelines for material placement in marsh creation (4A08); heavy metal uptake by marsh grasses (4A15); prediction of a stable elevation for marshes created on dredged material (4A16); establishment of marsh grasses on dredged material (4B06); review and examination of disposal-area filling techniques and rates to identify nonconflicting wildlife enhancement alternatives (5B04); and field studies at Branford Harbor, Connecticut (4A10), James River, Virginia (4A11), Buttermilk Sound, Georgia (4A12), Bolivar Peninsula, Texas (4A13), Dyke Marsh, Virginia (4A17), San Francisco, California (4A18), Apalachicola, Florida (4A17), and Miller Sands, Oregon (4B05). These studies will be used in the development of synthesis reports on marsh productivity and succession on dredged material (4A22), the engineering and economic considerations of habitat development (4A23), and marsh plant establishment on dredged material (4A24).


JOHN L. CANNON
Colonel, Corps of Engineers
Commander and Director

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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18. SUPPLEMENTARY NOTES Appendix B, "Completed Information Request Forms," was reproduced in microfilm and is enclosed in an envelope in the back cover of this report.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Marshes		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Information on deliberate marsh establishment work that is planned, underway or completed throughout the contiguous United States within the period of 1970- 1976 has been identified through (1) literature review, (2) interviewing people who, during the period of May 1975 through January 1977, have become known to be potential sources of pertinent information, and, (3) the completion of distributed information request forms by various correspondents. Excluding WES Excluding U. S. Army Engineer Waterways Experiment Station (WES) projects currently underway, marsh establishment projects at 105 district locations have		

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Eighteen projects were sited

been completed for at least 1 year and 14 projects are planned for the immediate future. Out of the 105 completed or continuing marsh establishment projects, ⁹~~nine~~ were totally unsuccessful (due to vandalism, Canada geese eat-out, wave exposure too severe for seeding, or site surface elevations too low for seeding). Variation encountered in projects included 18 that existed ~~in~~ freshwater or nearly freshwater locations, 68 ~~that existed~~ on the east coast, 17 on the gulf coast, 8 on the west coast, and 12 inland; ⁵⁹~~Fifty-nine~~ were purely experimental, as opposed to applied or partly so.

From information received and collated, practical guidelines for site preparation, marsh establishment, and site management and maintenance were developed and are discussed ~~herein~~. The two most important factors found for preparing a site for marsh establishment were surface slopes and surface elevations. Within the tidal zone, surface slopes should be developed such that they exhibit reasonable stabilities in the absence of vegetative cover. Surface elevations must be carefully considered in the design and planning of a project and tied in with the various zones of marsh types existing in the region. Surface elevations are most important and their acceptable tolerances most stringent in areas subject to tidal amplitudes of 2 ft or less. Long-term consolidation of fine sediment types is not considered of practical importance in achieving final surface elevations within acceptable tolerances. Close coordination between the site preparation and the marsh establishment stages of a project in terms of time of year is considered important; however, the use of nursery plant stock may alleviate the consequence of unacceptable marsh establishment because of unavoidable delays in the site preparation.

All aspects of marsh establishment must be an integral part of the design and planning of the total project. Selection of the plant species to be used in the various available elevation zones at the site must be governed by (1) the plant species known to exist within these zones in natural marshes in the region, (2) the objectives of the project, (3) the relative growth rates and sediment stabilizing capabilities of the candidate plants, and (4) the relative food value ratings of the candidate plants stock that can be successfully used at the site will depend upon (1) the available surface elevations at the site, (2) the exposure of the site to various physical stresses, and (3) the time of planting.

Properly developed nursery stock is considered superior to all other types for sites or sections of sites subjected to high wave and debris deposition stresses and for summer, fall, and winter plantings. Marsh establishment by seeding is considered feasible only in the spring, in sheltered or confined areas, and at elevations above mean tidal level (MTL) (preferably the upper 20% of the mean tidal range). Although exceptions are discussed, a rule of thumb is that increasing the maturity of nursery transplant materials upon decreasing the elevations in the tidal zone will lead to the greatest survival of transplants and the best overall plant establishment. Transplant spacing and fertilization requirements are discussed. Although fertilizations should be conducted for all marsh establishment work in sand sediments, the need for such fertilizations in other sediment types (silt-clay) is not readily determined.

Three principal maintenance and management requirements for marsh establishment determined by the study are (1) removal of debris and litter depositions, (2) protection against waterfowl depredation, and (3) fertilization. During the growing season, particularly for late spring and summer plants, algae, submerged aquatic plants, free-floating aquatic plants, and/or sundry debris that have been washed and deposited throughout the developing marsh, may have to be periodically removed. Otherwise, the affected plants may be seriously impaired. Depending upon the prevailing populations of geese, and to a lesser extent other wildlife, marsh establishment sites may have to be protected by enclosures or other effective devices. Areas of marsh establishment sites subject to extended periods of high wave stress may require annual maintenance fertilizations to prevent the marsh from succumbing to the stress.

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PREFACE

The work described in this report was performed under Purchase Order DACW39-75-M-4215 between the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi, and Environmental Concern, Inc., St. Michaels, Maryland. The study was sponsored by the Office, Chief of Engineers (DAEN-CWO-M), under the Civil Works Dredged Material Research Program (DMRP).

The research was conducted by Dr. E. W. Garbisch, Jr., during the period from June 1975 to January 1977. This report was prepared for the Habitat Development Project (Dr. Hanley K. Smith, Manager) under Work Unit 4A25, which is part of Tasks 4A: Marsh Development under the general supervision of Dr. John Harrison, Chief, Environmental Effects Laboratory (EEL). Dr. Luther F. Holloway of EEL monitored the study.

COL G. H. Hilt, CE, and COL J. L. Cannon, CE, were Directors of WES during the period of this purchase order, and Mr. F. R. Brown was Technical Director.

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CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI)
UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
inches	0.0254	metres
feet	0.3048	metres
miles (U. S. statute)	1.609344	kilometres
acres	4046.856	square metres
cubic yards	0.7645549	cubic metres
ounces (U. S. fluid)	29.57353	cubic centimetres
pounds (force) per acre	0.000112	kilograms per square metre
miles (U. S. statute) per hour	1609.344	metres per second

INTRODUCTION

Deliberate marsh establishment is a relatively new process that is of particular interest to the U.S. Army Corps of Engineers because it may occasionally offer an environmentally attractive alternative for the disposal and the use of dredged material. The adoption of marsh establishment as an integral component of federal maintenance dredging projects has been encouraged by Sec. 150 of the Water Resources Development Act of 1976. Section 150 specifically allows potential funding to plan and establish wetland areas as part of any water resources development project that is authorized by the Chief of Engineers.

A recent survey and evaluation of marsh plant establishment by Kadlec and Wentz (1974) uncovered few reports dealing with either natural or deliberate establishment. Concurrent with and subsequent to this survey, sufficient new marsh establishment work has either been completed, initiated, or planned so as to warrant updating existing knowledge, particularly that which would be of practical value to those designing and executing new marsh establishment projects.

The objectives of the work reported herein are (1) to identify, collate, and evaluate information on all marsh establishment work that is planned, underway, or completed throughout the contiguous United States within the time frame of 1970-76, (including earlier work that was not included in the survey by Kadlec and Wentz (1974)), and (2) to provide practical recommendations and guidelines, based on current information, for site preparation, marsh establishment, and site management and maintenance that may be useful in the design and planning phases for any new marsh establishment project.

The coastal zones and inland waterways throughout the United States present such varied project site characteristics that it is impractical to believe that broad guidelines for marsh

establishment can ever be developed and confidently applied. Marsh establishment projects must be designed site-specifically using available guidelines to an extent that can be justified.

The Dredged Material Research Program (DMRP) at the U.S. Army Corps of Engineers Waterways Experiment Station (WES) has been intensively studying marsh establishment on dredged materials since 1973. As this report is being prepared for WES, the scope of work did not include a review of its projects. Existing WES projects are listed in Table 1, but specific results of the work to the extent that they are available have not been considered in this report.

A marsh, in this report, is considered to be a community of emergent aquatic plants existing under natural conditions. The results of work on the establishment of submergent communities of aquatic plants, commonly known as seagrasses, baygrasses, or rivergrasses, are not considered herein. Additionally, the establishment of a marsh is considered to be equivalent to the establishment of a desired community of emergent aquatic plants on sediments having appropriate elevations relative to the regional water table or tidal range (Garbisch and Coleman 1977). The colonization of the new marsh by compatible communities of benthic invertebrates and the utilization of the new marsh by wildlife appear to accompany vegetative establishment (Environmental Concern Inc., pers. comm.; Cammen, Seneca, and Copeland 1974; Garbisch, Woller, and McCallum 1975a, b; San Francisco District CE 1976); however, there may be some contention as to when the functions of an established marsh become equivalent to those of a natural one. When the referenced natural marsh has the same (1) age of plant development, (2) sediment composition, (3) water salinity, and (4) exposure as the established marsh, such contention would be negligible.

METHODS

Although a survey of current (1974-76) reports on marsh establishment work was made, much of the work that is planned, in progress, or completed has not been formally reported. Unreported and current information was acquired by personal interviews (visit, letter, or phone) with people who, during the period of May 1975 through January 1977, have been identified as potential sources of marsh establishment information. Additional information was obtained from those correspondents who completed and returned information request forms. A list of the names, addresses, and telephone numbers of all correspondents is given in Appendix A and the completed forms are collected in Appendix B.

Several correspondents in North Carolina and in Florida were unwilling to meet or to transmit unpublished information of their work. All other correspondents freely transmitted results and opinions. Certainly, some important work in marsh establishment has been omitted; however, it is felt that this report reflects a reasonably accurate overview of the field through 1976.

HISTORICAL PERSPECTIVE

Serious freshwater and brackish water marsh establishment work that was related to wildlife habitat development, improvement, and management began in the United States around the turn of the century. This work, which has been reviewed by McAtee (1939) and Martin and Uhler (1939), was qualitative and poorly documented by modern scientific standards. Yet it provides practical information related to marsh establishment that continues to guide management practices in State and Federal wildlife areas and in private hunting areas throughout the country. Such practices, however, have not been documented well.

Reports of new work on marsh establishment were not available for some thirty years at which time Statler and Batson (1969) and Statler (1973) described the results of transplanting salt marsh plants in South Carolina, and the USDA Soil Conservation Service (1968) provided preliminary guidelines for abating shore erosion through marsh establishment. The Soil Conservation Service has continued its work and interest in the application of marsh establishment for shore erosion control (Sharp and Vaden 1970), although such work has yet to receive broad public acceptance.

At the same time, the U.S. Army Corps of Engineers Coastal Engineering Research Center (CERC), various regional CE Districts, Environmental Concern Inc., Department of Commerce (NOAA), and the North Carolina Coastal Research Program initiated both research and the application of the intentional establishment of salt marsh on dredged and fill materials for new habitat development (Woodhouse, Seneca, and Broome 1972, 1974; Broome, Woodhouse, and Seneca 1974; Eleuterius 1974; Terry, Udell, and Zarudsky 1974; Garbisch and Woller 1975; Garbisch, Woller, and McCallum 1975a, b, c; Kinch 1975; Dunstan, McIntire, and Windon 1975; and San Francisco District CE 1976); and CERC, the Omaha District CE, the Florida DNR, several organizations in Florida, and Environmental Concern Inc. pursued marsh establishment for shore erosion control (Savage 1972; Woodhouse, Seneca, and Broome 1974, 1976; Cariton 1974; Stanley and Hoffman 1974, 1975; Garbisch, Woller, and McCallum 1975a; Garbisch 1976, 1977; Dodd and Webb 1975; Teas, Jergens, and Kimball 1975; and Webb and Dodd 1976). Currently, there are available guidelines for material placement in marsh establishment (Johnson and McGuinness 1975), criteria for new marsh-island site selections (Coastal Zone Resources Corp. 1976), planting guidelines for marsh development (Darovec et al. 1975, Knutson 1977), specifications for marsh plant establishment and guidelines for new marsh site suitability (Environmental Concern Inc. 1976), and standards and specifications for tidal bank stabilization (Soil Conservation

Service 1975).

All of the recently reported marsh establishment work has been conducted in tidal saline waters with the exception of two tidal freshwater projects (Ristich, Fredrick, and Buckley 1976; Garbisch and Coleman 1977) and one inland freshwater project (Stanley and Hoffman 1974, 1975). Two of the five WES marsh establishment projects that are currently underway are in freshwater locations (Smith, pers. comm.). CERC is currently pursuing marsh establishment work at a low salinity location in North Carolina (Knutson, pers. comm.), and Environmental Concern Inc. is continuing freshwater marsh establishment work in the northern reaches of the Chesapeake Bay.

DISCUSSION

All identified (reported and unreported) marsh establishment projects that have been completed, initiated, and planned from 1970 through 1976 are collected in Tables 1 and 2. The names and addresses of all of the people with whom the principal investigator corresponded are given in Appendix A. Salient aspects of many of the tabulated projects are given in the returned questionnaire forms (Appendix B). All of the following statements not referenced or that are noted (Environmental Concern Inc., pers. comm.) reflect the opinions of the principal investigator.

(1) Guidelines for Site Preparation.

Little information was obtained from the correspondents concerning requirements for site preparation. However, from reported work (Woodhouse, Seneca, and Broome 1972, 1974, 1976; Garbisch and Woller 1975; Garbisch, Woller, and McCallum 1975a, 1975c; Garbisch 1976; Garbisch and Coleman 1977), it is clear that the two most important factors in preparing a site for marsh establishment on dredged or fill materials (sloped shores, slopes

Table 1. Recent WES marsh establishment projects conducted throughout the contiguous United States.^a

Institution	Project Identification and Location	Date	Site Conditions ^b (tidal amplitude, ft)	Plant Species ^c	Plant Stock ^d	Project Design ^e	Project Status ^f	Questionnaire Form No.
EAST COAST								
Town of Huntington, Dept. of Environmental Protection	Wetlands Restoration, ten project locations in Long Island Sound near Huntington, NY	1974-76	SW; N except R at one site; combinations of P, S, & M (7.4)	SA, SP	NP	appl	9-active 1-inactive	1
Town of Islip, Dept. of Environmental Control	Sand Island, in Great South Bay near Islip, NY	1974-	SW, U, S	SA	N from NP	exp & appl	active	2
	East Islip Marina, East Islip, NY	1974-75	FW (pond), U, S	TL, Sa	P	appl	active	3
Boyce Thompson Inst. for Plant Research	Transplantation of Iypha at Camp Smith, NY (Hudson River mile 44)	1971-73	5 ppt SW, R (2.9)	TA	BR	exp plot	active	g,h
Town of Hempstead, Dept. of Conservation & Waterways	North Line Island, near Point Lookout, NY	1974-76	SW, U, S (3.6)	SA	NP	appl	active	4
Town of Hempstead, Dept. of Conservation & Waterways & the Marine Sciences Research Center SUNY	North Line Island, near Point Lookout, NY	1973	SW, U, S-M (3.6)	SA	P, S, NP	exp	active	g,i
New York District	North Line Island, near Point Lookout, NY	1976	SW, U, S-M (3.6)	SA	S	exp	inactive ⁱ	g,i
U.S. Dept. of Interior, National Park Service	Plum Beach, Brooklyn, NY	1976	SW, R, 0 (3)	SA	S	appl	active ^j	g,k
Environmental Concern Inc.	San Domingo Creek near St. Michaels, MD, in mid-Chesapeake Bay	1971	SW, C, S-M (1.4) ^l	SA, SR, TA, PC, JR	P	exp	active	g
	Hambleton Island (quarry fill), near St. Michaels, MD, in mid-Chesapeake Bay	1972	SW, U, S (1.4) ^m	SA, SP, SC, TL, TA, PC, Sa, SR, SO, JR, DS, PV, AB	N, S	exp & appl	active	5

(Continued)

(1 of 8 sheets)

Table 1 (continued)

Institution	Project Identification and Location	Date	Site Conditions (tidal amplitude, ft)	Plant Species ^c	Plant Stock ^d	Project Design ^e	Project Status ^f	Questionnaire Form No.
Environmental Concern Inc. (continued)	Hambleton Island (natural shore), near St. Michaels, MD, mid-Chesapeake Bay	1973-74	SW, N, S (1.4)	SA, SP	N	exp	active	6
	Hambleton Island (natural shore, silt & clay) near St. Michaels, MD, in mid-Chesapeake Bay	1972	SW, N, M (1.4)	SA	N	appl	active	7
	Hambleton Island (dredged material) near St. Michaels, MD, in mid-Chesapeake Bay	1973-75	SW, U, S-M (1.4)	SA, SC	N	exp	active	8
	Rich Neck, eastern shore of mid-Chesapeake Bay	1973-74	SW, N, S (1.2)	SA, SP, DS, AB	N	exp	active	9
	Tred Avon River, eastern shore of mid-Chesapeake Bay	1973-74	SW, N, P-5 (1.4)	SA, SP, DS, AB	N	exp	active	10
	Long Point Island, eastern shore of mid-Chesapeake Bay	1973	SW, N, S-M (1.5)	SA	N	exp	active	11
	Sand Spit, eastern shore of mid-Chesapeake Bay	1973	SW, N, S (1.5)	SA, SP, SC, PC, PV	N	appl	active	9
	Susquehanna Delta, upper Chesapeake Bay	1973	FW, N, S (1.7)	SA, SA, SO, SR, SC, TA, TL, PV	N, S, BR	exp	inactive ⁿ	12
	Tidal Stream Restoration, Ocean City, NJ	1973	SW, R, S, 0 (3.7)	SA, SP	N	appl	active	9
	White Stone, VA	1974	SW, N, S-M (1.1)	SA	N	appl	active	9
	Greenwich Point, Greenwich, CT	1974	SW, R, S-P (7.4)	SA, SP, SC	N	appl	active	9
	Centerport Beach, Huntington, NY	1974	SW, N, S (7.4)	SA	N	appl	active	0
	Sloop Channel near Quimby, VA	1974	SW, U, M (4.0)	SA	S, N	exp, appl	active ^P	13

(Continued)

(2 of 8 sheets)

Table 1 (continued)

Institution	Project Identification and Location	Date	Site Conditions ^b (tidal amplitude, ft)	Plant Species ^c	Plant Stock ^d	Project Design ^e	Project Status ^f	Questionnaire Form No.
Environmental Concern Inc. (continued)	Burton's Bay near Quimby, VA	1974	SW, U, M (4.0)	SA	S, N	appl	active ^p	14
	Tar Bay, eastern shore of mid-Chesapeake Bay	1974	SW, U, M (1.3)	SA, SP, DS	S	appl	active	15
	Slaughter Creek, eastern shore of mid-Chesapeake Bay	1974-75	SW, U, S-M (1.2)	SA, SP, SC, DS, AB, AA	N ^q	exp, appl	active	16
	Eastville, VA, eastern shore of lower Chesapeake Bay	1975, 76	SW, N, S (2.4)	SA, SP, AB	S, N	appl	active ^p	g
	Knapps Narrows, eastern shore of mid-Chesapeake Bay	1975	SW, U, S, (1.2)	SA	S	appl	inactive ^{p, r}	g
	Harris Creek, eastern shore of lower Chesapeake Bay	1975	SW, N, S (1.2)	SA	S, N	exp	inactive ^p	g
	Cober, eastern shore of lower Chesapeake Bay	1975	SW, N, S (1.2)	SA, SP	N	appl	active	g
	James River near Hopewell, VA	1975	FW, C, S-M (2.3)	SA, SC, SR, SA, PV, PV, PA	S, N	exp, appl	active	t
	Kittery, ME	1975	SW, R, M-0 (8.7)	SA, SP	N	appl	active	g
	Ridge, MD, western shore of mid-Chesapeake Bay	1976	SW, C, M (1.2)	SA	S	appl	active	g
	Seaford, NY	1976	SW, U, S (3.6)	SA, SP, DS, PV, PA	S	appl	active ^u	g
	Northeast, MD, upper Chesapeake Bay	1976	FW, N, S, 0 (1.9)	Pv, Pc	S, N	exp plot	active	v
	Ray's Point, MD, eastern shore of mid-Chesapeake Bay	1976	SW, N, S (1.4)	SA, SP	N	appl	active	g

(Continued)

3 of 8 sheets)

Table 1 (continued)

Institution	Project Identification and Location	Date	Site Conditions ^b (tidal amplitude, ft)	Plant Species ^c	Plant Stock ^d	Project Design ^e	Project Status ^f	Questionnaire Form No.
Environmental Concern Inc. (continued)	Slaughter Creek, eastern shore of mid-Chesapeake Bay	1976	SW, N, S (1.2)	SP	N	appl	active	g
	Virginia Beach, VA	1976	SW, R, M-O (3.4)	SA	N	appl	active	g
	Virginia Beach, VA	1975	SW, R, M-O (1.5)	SA	P	appl	active	g,w
Environmental Consultants, Inc.	Sloped river banks in VA (five sites)	1958	SW, U, S-M	SA, SP, PV	P	appl	active	g,x
USDA Soil Conservation Service	Snow's Cut, NC	1971	SW, U, S (3.9)	SA	S, N, BR	exp	active	17
North Carolina State University	Beaufort, NC	1972	SW, U, S (3.0)	SA	S, BR	exp	active	18
	South Island, NC	1973	SW, U, S (2 - 2.5)	SA	S	exp	active	19
	Pine Knolls Shores, NC	1974	SW, U, S (2 - 2.5)	SA	S, N, BR	exp	active	20
	Six additional locations for preliminary testing & field scale work in NC	1969-73						
CERC	Field Research Facility, Duck, NC	1973-76	2-3 ppt. SW, N, S (1.0)	SA, JR, PC, TL, TA	BR	exp	active	g,y
Skidway Institute	Hell Gate near Ossabaw Sound, GA	1973	SW, U, M (8.1)	SA	P	exp	active	g,z
GULF COAST								
Texas A & M University	East Galveston Bay	1974-76	SW, N, S-M (1.5)	AD, AG, DS, JR, PC, SA, SO, SR, SA, SC, SS, TG	BR	exp plot	active	g,aa
Marco Applied Marine Ecology Station	Mangrove transplantation on a dredged material island; Marco Island, FL	1972-74	SW, U, M (2.3)	RM, AG	2 - 8 ft trees	exp	active	21

(Continued)

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Table 1 (continued)

Institution	Project Identification and Location	Date	Site Conditions ^b (tidal amplitude, ft)	Plant Species ^c	Plant Stock ^d	Project Design ^e	Project Status ^f	Questionnaire Form No.
Florida Department of Natural Resources	Six project locations in Tampa and Sarasota Bays	1969-71	SW, N, S-M (≈ 2)	RM, LR, AG	S, P	exp	active	g,bb
University of Miami	One site near Port Charlotte (west coast) & three sites near Port St. Lucie (east coast)	1974-	SW, N & R, S-M (≈ 2)	RM	BR	appl	active	g,cc
Florida A & M University	Ocklockonee Bay, dredged material island	1973	SW, U, S (2.7)	SA, JR, DS	P	exp	inactivatedd	g,dd
Gulf Coast Research Laboratory	Seven project locations in Mississippi Sound: Horn Island Pass, Simmons Bayou, Gulf Park Estates Beach, Ocean Springs East Beach, Ship Island, Horn Island, and Petit Bois Island	1973	SW, U, S (1.7)	SA, SP, SC, DS, PC, JR, PR	P, BR, N	exp plot	active	g,ee
WEST COAST								
San Jose State University	Bay Bridge Approach, Grant Ave., Overpass, Oakland, CA	1969-71	SW, U, M (≈ 8)	SF, Sp, DS, GH	P, S	exp	active	22
	Faber Tract, Palo Alto, CA	1971-	SW, C, M (≈ 8)	SF	P	exp	active	22
	Anza Pacifica, Burlingame, CA	1974-	SW, C, M (≈ 8)	SF	P, S, N	exp	active	22
San Francisco Bay Marine Research Center, San Jose State University, San Francisco District	Alameda Creek, Newark, CA	1974-	SW, U, M (≈ 8)	SF, Sp	P, S, N	exp	active	22, 23, 24
San Francisco Bay Marine Research Center	Marsh Establishment for Shore Erosion Abatement, three sites	1976	SW, N, M (6.8)	SF	P	exp plot	active	g,ff
Madrone Associates	Marion County Day School Marsh bordering Corte Madera Bay	1975	SW, N, S (≈ 5)	SF	P	exp	active	g,gg

(Continued)

(5 of 8 sheets)

Table 1 (continued)

Institution	Project Identification and Location	Date	Site Conditions ^b (tidal amplitude, ft)	Plant Species ^c	Plant Stock ^d	Project Design ^e	Project Status ^f	Questionnaire Form No.
INLAND								
University of South Dakota	Twelve project locations on the shorelines of Lake Oahe and Lake Sakakawea Mainstem Missouri River	1973	FW, N, S-M	Pa, PV, PC, DS, TL, SV	S, P	exp	active	g,hh
DMRP projects underway (not covered in the text of this survey)	Windmill Point Marsh Development Site, James River, VA	1975	FW, C, S-M					
	Buttermilk Sound Marsh Development Site, near Brunswick, GA	1975	SW, U, S					
	Bolivar Peninsula March & Terrestrial Habitat Development, Galveston Bay, TX	1976	SW, U, S					
	Pone #3 Marsh Development Site, San Francisco, CA	1976	SW, U, M					
	Miller Sands Island, Columbia River, OR	1976	FW, U, S					

(Continued)

Note: Footnotes are on sheets 7 and 8.

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Footnotes to Table 1.

- a) Project areas are all 3 acres or less unless otherwise noted.
- b) SW = salt or brackish water, FW = freshwater, S = sand, P = pebbles, M = mud, O = high organic or peaty, U = unconfined dredged or fill materials, C = confined dredged or fill materials, N = natural shore, R = restoration of disturbed or destroyed marsh.
- c) Major plant species used is underlined. AA = *Ammophila arenaria*, AB = *Ammophila breviligulata*, AD = *Arundo donax*, AG = *Avicennia germinans*, DS = *Distichlis spicata*, GH = *Grindelia humilis*, JR = *Juncus roemerianus*, LR = *Laguncularia racemosa*, PA = *Panicum amarulum*, Pa = *Phalaris arundinacea*, PC = *Phragmites communis*, PC = *Pontederia cordata*, PR = *Panicum repens*, PV = *Panicum virgatum*, PV = *Peltandra virginica*, RM = *Rhizophora mangle*, SA = *Spartina alterniflora*, Sa = *Scirpus americanus*, SC = *Spartina cynosuroides*, SF = *Spartina foliosa*, SO = *Scirpus olynei*, SP = *Spartina patens*, Sp = *Salicornia pacifica*, SR = *Scirpus robustus*, SS = *Spartina spartinae*, SV = *Scirpus validus*, TA = *Typha angustifolia*, TG = *Tamarix gallica*, IL = *Typha latifolia*.
- d) P = plugs taken from neighboring marshes, N = self-produced nursery stock, NP = nursery stock purchased from Environmental Concern, S = seed, BR = bare root or rhizome stock extracted from a natural or man-made marsh (field nursery).
- e) "exp" indicates experimental project, "exp plot" indicates an experimental plot design and "appl" indicates nonexperimental with principal objective to establish a marsh.
- f) "active" indicates that the project was generally successful and "inactive" indicates that the project was unsuccessful for the reasons referenced.
- g) No questionnaire was completed. Contact institution for additional information.
- h) Ristich, Fredrick, and Buckley 1976.
- i) Terry, Udell, and Zarudsky 1974.
- j) The purpose of this project was to test the use of Holdgro, a polypropylene netting with interwoven paper manufactured by Gulf States Corp., in the broadcast seeding of tidal dredged material. After surface seeding, Holdgro was stapled to the treated surface of the dredged material. No fertilizer was applied. No seedlings were found to emerge through the Holdgro and the project was considered unsuccessful. Will and Susykowski (pers. comm.).
- k) Seed germinated late and seedling coverage was sparse following the first growing season, Silverstein (pers. comm.).
- l) Fill area enclosed by low profile riprap breakwater.
- m) The most exposed side (west) of the project area was protected by portable plastic breakwaters.
- n) Canada geese depredation during the winter following the first growing season led to complete loss of all established vegetation.

Footnotes to Table 1 (continued)

- o) See Site-I in questionnaire No. 1.
- p) All seeding work failed.
- q) Sprigs of SP, AB, and AA were provided by the SCS Cape May Plant Materials Center.
- r) Available elevations were too low (MSL) for seeding to have any promise of success.
- s) Depositions of organic debris buried all transplants.
- t) New WES habitat development project.
- u) The elevations of the 14-acre site were mostly 3-5 ft above mean high water (MHW).
- v) Garbisch and Coleman 1977.
- w) Birdsong and Levi (pers. comm.).
- x) Sharp and Vaden 1970.
- y) Herme and Knutson (pers. comm.).
- z) Dunstan, McIntire, and Windon 1975.
- aa) Dodd and Webb 1975.
- bb) Savage 1972.
- cc) Teas, Jergens, and Kimball 1975.
- dd) Transplants failed to become established probably because the elevations were too low, Coultas (pers. comm.).
- ee) Eleuterius 1974.
- ff) Knutson (pers. comm.).
- gg) Kingsley (pers. comm.).
- hh) Stanley and Hoffman 1974, 1975 (pers. comm.).

Table 2. Planned marsh establishment projects in the contiguous United States

Institution	Project Objective
EAST COAST	
The Port Authority of Providence, RI, and the Coastal Resources Center, University of RI ^a	To use Watchemoket Cove as the disposal area for dredged material removed from Providence Harbor and to establish 50+ acres on these materials to mitigate the environmental impacts of dredging. Preliminary design and feasibility studies have been completed and the project currently is on a "hold" status.
Town of Fairfield, CT, Conservation Commission ^b	To restore \approx 200 acres of former salt marsh of the Pine Creek estuary that was diked some 80 years ago for flood control and that subsequently converted naturally to a monotypic stand of <i>Phragmites communis</i> . The restoration design includes salt marsh revegetation by natural processes and controlled burning of <i>P. communis</i> after introducing regular tidal action of the area. The project is scheduled for 1977-78.
Town of Islip, NY, Dept. of Environmental Control ^c	To establish salt marsh on confined silt and clay dredged material that has been consolidating for 3 years. Vegetative establishment throughout the dike and the tidal dredged material will be accomplished by transplanting suitable plant stock in 1977.
Environmental Concern Inc.	To restore \approx 10 acres of salt marsh destroyed through sewer line installations in Manahawkin Bay, NJ, and Portland, ME. ^d The projects will utilize nursery stock and are scheduled for 1977.
	To utilize salt marsh establishment for shore erosion control at five locations in the mid-Chesapeake Bay. Work scheduled for 1977.
GULF COAST	
Tampa Port Authority, Tampa, FL ^e	To establish \approx 23 acres of salt marsh on confined fine-sized dredged material at Pendola Point in Hillsborough Bay, FL. The project is presently in a "hold" status.
^a) Tippie (pers. comm.). Environmental Concern Inc. 1976. Allender, B. M. and C. Roman. 1976. ^b) Steinke (pers. comm.); Steinke, T. J. 1974. ^c) Brunn (pers. comm.). ^d) Work being subcontracted by Cianbro Corporation, Pittsfield, ME, and Environmental Dredging, Inc., Wenonah, NJ 08090. ^e) Chula Vista Boat Basin/Wildlife Reserve Draft EIR (UPD #7563-EIR-15 San Diego Unified Port District 1975. Smith, D. D. 1976.	

Table 2 (continued)

Institution	Project Objective
WEST COAST	
San Diego Unified Port District	To establish 70 acres of saltmarsh and wildlife reserve on an estimated 100-acre island constructed from mud and sand materials dredged from the Chula Vista small boat basin in San Diego Bay, CA. Project time frame is 2 to 3 years, anticipated starting year is 1978.
The Resources Agency of California, Dept. of Fish and Game ^g	To reestablish 150 acres of salt marsh in Balsa Chica Bay. Tide gates constructed in 1899 led to the destruction of the saltmarsh. After tidal flows are restored, it is considered that the tidal area will naturally revegetate. The project site is located between the cities of Huntington Beach and Seal Beach, CA. Starting date uncertain.
City of Palo Alto, CA ^h	To restore 200 acres of salt marsh lost as a result of tide gate construction for flood control. After opening the flood basin to tidal influence, it is expected that salt marsh revegetation will take place naturally. Contract negotiations underway, 1977. ^h
Golden Gate, Highway and Transportation District ⁱ	To restore 120 to 140 acres of diked and filled (dredged material) salt marsh on the Muzzi property in Corte Madera, CA. Dredged material disposal was completed in 1975 and the dikes were breached in June 1976. Seeding and transplanting salt marsh vegetation is planned for 1977.

^g) The Resources Agency of California 1974.

^h) White and Crowder (pers. comm.).

ⁱ) Faber (pers. comm.) and Kingsley (pers. comm.).

of dikes, and natural shores) are (1) surface angles of repose (slopes) and (2) surface elevations. If either or both of these factors are not properly constructed during the site preparation, marsh establishment will be jeopardized.

(a) Slopes. Suitable surface slopes for developed (unnatural) sites that are unprotected or unconfined will be site-specific and will depend on factors such as natural and induced wave and current climates and the physical characteristics of the fill materials. For tidal saline areas, Woodhouse, Seneca, and Broome (1974) suggest developing slopes that are as gentle as practicable without creating ponding of tidal water; Garbisch and Woller (Q 15-8)* recommended slopes between 30:1 (horizontal:vertical) and 15:1 for an exposed site having mounded unstable sandy sediments developed at the hydraulic pipe outfall location; Garbisch, Woller, and McCallum (1975a) indicated that unvegetated mud sediments developed to a slope of 60:1 were stable; Hair and Brunn (Q 2-4) indicated a suitable slope of 25:1 for an exposed sandy sediment site; and Knutson (1977) recommended slopes of 15:1 or less for seeding and for transplanting.

At this time the best recommendation for the tidal zone, including the EHT elevation (the estimated highest tide from storm and/or wind setup), is to design unconfined material (including earthen dike) surface slopes that are as low as practicable without impounding water and not to achieve or exceed slopes that are deemed to be appreciably unstable under normal conditions in the absence of vegetative ground cover. For contract specifications, the upper limit of surface slopes can be calculated by the project engineer or can be estimated from the prevailing slopes of the non-eroding sections of shores at and contiguous to the site (provided that the shore sediments are compatible with those being dredged). Site elevations above EHT can accommodate much steeper slopes (i.e. ca. 3:1) than those

*Q a-b = Questionnaire No.-page, Questionnaire 15, page 8 (see Table 1 and Appendix B, Appendix B carries corresponding numbers in the upper right-hand corner of each page).

within the tidal zone. Standards and specifications set by the regional Soil Conservation Service should be used as guidelines for high elevation slopes.

Sites developed by hydraulic dredge disposal will generally encounter material mounding at each pipe outfall location. This results from sediment sorting at the outfall with the heavy particles being retained near the outfall location and the fine particles flowing to distances more remote from the outfall location. These mounds may have steeper slopes than acceptable (Garbisch and Woller 1975 and Q 15-8), and will have to be graded as discussed above.

(b) Elevations. Proper surface elevations are essential for successful marsh establishment. The matter becomes critical in areas subject to low tidal amplitudes of less than 2 ft.* For example, a 4-acre marsh establishment project was unsuccessful because the final elevations were developed 3 to 6 in. too low (see Environmental Concern Inc., Knapps Narrows project, Table 1). The permissible tolerance in the final elevations should be clearly specified in the site preparation work contract. The particular marsh plant species that can be established and the plant materials to be planted both depend upon elevation (Woodhouse, Seneca, and Broome 1974, 1976; Garbisch and Woller 1975 and Q 5-6ff; Garbisch, Woller, and McCallum 1975a; Environmental Concern Inc. 1976; San Francisco District CE 1976; Knutson 1977; Garbisch and Coleman 1977).

If at all possible, a person or firm with marsh establishment experience should be consulted in the early stages of a project's design and planning. Physical and biological engineering inputs are required for all marsh establishment projects. If the project involves adding material to a site, the capacity of the site must be compatible with the forecasted volume of material to be added. The capacity of a specific site is a function of the surface elevation of the fill material, which

* A table of factors for converting U. S. customary units of measurement to metric (SI) units can be found on page 5.

in turn dictates the marsh plant species, if any, that can be established. A variance of 4,000 cubic yards of uniformly distributed fill materials at a one-hectare site corresponds to a elevation variance of one foot. This level of variance is acceptable for areas subject to tidal amplitudes of approximately 5 to 10 ft, but is unacceptable for areas subject to lower tidal amplitudes.

Accurate (± 0.1 ft) soundings throughout a potential marsh establishment dredged material disposal site should be made during the flood or ebb tide and at times when the water level reaches the high and low fringes of each zone of marsh type in the immediate area. If this is impracticable, accurate soundings should be made by standard methods and referred to MHW, MTL, or mean low water (MLW). These data then can be used in the project design. Prior to fill material disposal, elevation pipes should be established throughout the site to assist the site preparation contractor in determining when the required elevations have been achieved.

Surface elevation considerations are no less important in the design and execution of marsh establishment for restoration and shore erosion control where filling is not required.

The consolidation of fill materials and the settling of these materials into soft and displaceable water bottoms will affect the final surface elevations at the site as well as the real capacity (volume) of the site. These engineering estimates, which in themselves are difficult to compute, are complicated by (1) the biological (marsh establishment) assist in consolidation through dewatering of the fill materials and (2) the organic input to the fill materials (approximately 50% of total annual net production of species is found underground - see Q 5-6ff). Of the fourteen marsh establishment projects listed in Table 1 that were conducted on confined or unconfined mud (silt and clay) dredged or fill materials, there was no mention of surface elevation decreases that might be attributed to long-term consolidation

following initial site preparation - even in instances where elevations were surveyed (Garbisch and Woller 1975; Garbisch, Woller, and McCallum 1975a,c). Whereas short-term (days) sediment consolidation considerations are important in the design and initial preparation of the site, once surface elevations have been achieved and appear to be stable (within days), long-term (months) sediment consolidation considerations do not appear to be of practical importance. Further information on the practical importance of long-term sediment consolidation for site preparations will be available from current studies conducted by WES (Smith, pers. comm.).

(c) Coordinating Site Preparation and Marsh Establishment. Another important factor in site preparation is that of timing the completion of the site preparation phase of the project so that the marsh establishment phase can proceed on schedule. This is particularly important if vegetative establishment is to be conducted by seeding and sprigging dormant or growing plants. The optimum time for seeding and sprigging is in the spring (March, April, and May) throughout the east and west coasts (Woodhouse, Seneca, and Broome 1976, Environmental Concern Inc. 1976, Knutson 1977); however, more information on this is needed for Mangroves, freshwater marsh species, and salt-marsh species of genera other than Spartina.

Unless it is known otherwise, the probability of successfully establishing a marsh by seeding or sprigging in the summer and fall should be judged to be low. One exception is if potted nursery stock is designated for use. Such stock, if appropriately developed, can be successfully planted 12 months of the year (Environmental Concern Inc. 1976), and its use relieves the urgency of closely coordinating site preparation and marsh establishment.

If for any reason marsh establishment is delayed and interim stabilization of the prepared site is judged to be necessary - or

for additional stabilization during vegetative development, Hair and Brunn (Q 2-4) recommend the use of Vexar netting stapled to the sediment surface. Other types of temporary protective structures have been used (Garbisch and Woller, Q 5; Seneca, pers. comm; Webb and Dodd 1976; Dodd and Webb 1975; Smith, pers. comm.).

(d) Sediment Types. There is no reported limitation of uncontaminated sediment types to marsh establishment, with the exception of marsh peat sediments. Seneca, Woodhouse, and Broome (1976), Environmental Concern Inc. (pers. comm.), and Garbisch and Coleman (1977) indicate that such sediments can be expected to support poor plant growth and to render high transplant mortalities. Although fertilization assists plant establishment in peaty sediments (Garbisch and Coleman 1977), machine or hand planting on these sediments is difficult. Generally, Environmental Concern Inc. recommends that because of its poor fertility, poor nutrient adsorption capacity, low water exchange potential, high acidity when disturbed and subject to oxidation, and restriction to vegetative spread when in a consolidated state, marsh peat is the least desirable substrate for marsh restoration or development.

There is no compelling reason to consider artificially mixing, layering, or exchanging sediment types in the preparation of a site for marsh establishment unless such work is proposed on marsh peat sediments.

Silt-clay sediments may develop desiccation fissures, particularly if confined without tidal influence for long periods or at the uppermost tidal elevations if unconfined. Such fissures may fill in time (Dunstan, McIntire, and Windon 1975). If the situation is not naturally remedied prior to the planting phase, the sediments would have to be prepared by tillage or other methods.

The principal problem with fine sediment types in marsh

establishment work is that they may present the planting contractor with major obstacles in satisfactorily accomplishing his work. This problem cannot be simply resolved during the site preparation phase and must be confronted at the time of marsh establishment.

2. Guidelines for Marsh Establishment.

Marsh establishment at a given site should include the following considerations and actions:

- (i) Delineate the various elevations zones (i.e., MLW-MTL, MTL-MHW, MHW-EHT or low, mean, high) at the site and their respective areas.
- (ii) Assess the potential exposure of the site to natural and boat-induced wave, litter and debris deposition, suspended coarse sediment, and animal stresses.
- (iii) Identify the plant species that are to be assigned to the available elevation zones.
- (iv) Identify the types of plant stock that are compatible with the available elevation zones, potential stresses, and the time of planting.
- (v) Determine the plant spacings and seeding rates that are required to produce the desired vegetative cover in the allotted time period.
- (vi) Determine the need for and the application rate of fertilizer.
- (vii) Evaluate the need for future maintenance and wildlife management.

- (viii) Identify the planting techniques and labor force to be employed.
- (ix) Estimate the cost.
- (x) Obtain the plant materials.
- (xi) Execute the planting on schedule.

Items i - ix above should be fulfilled during the design and planning phases of a project with the consultation of a qualified person. During site preparation, the planting contractor should examine the site periodically (1) to ensure that the specified elevation zones and grades are being achieved, (2) to assist in resolving unforeseen construction problems that may affect marsh establishment, and (3) to recommend minor preparation improvements that would facilitate marsh establishment, but that would not require change orders to the scopes of work and costs of the various contracts. Such change orders often are unavoidable, but they may cause substantial delays in the development of a project.

(a) Marshscape Architecture. The plant species that are assigned to the various elevation zones that are or will be available at the site should be selected from those that are occupying or are known to occupy these zones in regional natural marshes. There may often be choices to make. For example, should Juncus roemerianus and/or Spartina alterniflora be established in the MTL to MHW zone of a tidal saltwater site in southeast United States? Should S. alterniflora, S. spartinae, and/or Rhizophora mangle be established in the MTL to MHW zone of a tidal saltwater site in the Gulf Coast? Should Peltandra virginica, Pontederia cordata, Scirpus americanus, and/or Typha latifolia be established in the MLW to MTL zone of a tidal freshwater site in the Hudson River? Should Distichlis spicata, Salicornia pacifica, and/or S. patens be established in the MHW to EHT zone of a mid-west coast site?

Such questions should be answered after considering the objectives of the project (i.e., erosion control, development of fish and wildlife habitat, restoration of a marshfill, biological control of water pollution) and the exposure of the site to physical and animal stresses. In general, for unprotected and unconfined sites with fetches of 10 miles or greater, do not plan to establish vegetation below MHW (Environmental Concern Inc. 1976; Knutson 1977). Other methods must be used to protect this area.

When contemplating the use of slow-growing plants such as mangroves (Savage 1972 and et al. 1975), consideration should be given to establishing a uniform cover of a faster stabilizing and a faster growing plant such as S. alterniflora with checkerboard transplants of the slow-grower (mangroves) throughout. This will render the protection often needed for the slow-growing transplants until such time that these achieve maturity and displace or remain in association with the faster growing plants (Lewis, pers. comm. and Lewis 1975). Before applying this concept, it should be confirmed from natural or empirical evidence that the slow-growing plant can develop satisfactorily in association with the dominant one. This concept has been applied to freshwater sites (Garbisch and Woller, Q 12 and James-River-near-Hopewell site under Environmental Concern Inc. in Table 1) using S. alterniflora. Although S. alterniflora normally is not found in tidal freshwater areas, it can be established successfully in such areas. Because of its rapid growth, excellent lateral spread, and superior sediment-stabilizing fine root structure, S. alterniflora can render stabilization of the site and temporary protection to the co-transplanted freshwater marsh plants until such time that these plants dominate the site.

Another consideration should be made during the assignment of plant species to the respective tide zones. This concerns the values of the plants as food for the wildlife (particularly waterfowl) which are expected to utilize the site. Excessive animal grazing or consumption of underground plant parts on a marsh

establishment site can have devastating consequences (Garbisch and Woller, Q 1,4,5,12; Savage 1972; Dodd and Webb, pers. comm.; Kingsley, pers. comm.; Knutson, pers. comm.; Stanley and Hoffman 1974, 1975; Garbisch, Woller, and McCallum 1975a, b; Garbisch and Coleman 1977). Establishing plants having both high and low food values for prevailing wildlife may reduce the necessity to use enclosures or other devices as protection against wildlife depredation (Garbisch and Coleman 1977). Plants selected must be known to naturally occur in association with each other.

The relative food values of aquatic plants for waterfowl have been reviewed by McAtee (1939) and Martin and Uhler (1939). Geese (Canada, snow, blue, and brant) in modest numbers of 10-100 can inflict permanent and widespread damage to both newly established and natural fresh marshes and salt marshes. The rhizomes of Spartina spp., Scirpus spp., and Typha spp. are favorite foods, while Peltandra virginica, Pontederia cordata, and Juncus roemerianus have low food values for geese. Canada geese generally work a marsh by eating out the seaward edge, progressing marshward (or landward). They quantitatively excavate and consume underground rhizomes, generally while floating. Water over the marsh facilitates the excavation process. Consequently, the vulnerability of the desirable plants to goose depredation increases from MHW to MLW. Above MHW, Canada geese will graze marsh and forage plants; however, snow and blue geese continue to consume underground parts.

Muskrats and nutrias may also present initial and continued problems in freshwater and brackish water marsh establishment. Both are large rodents, particularly nutrias. Muskrats prefer underground (particularly during winter months) and nutria prefer aboveground plant parts as food. Muskrats prefer feeding at night while water covers the marsh surface. They will tunnel into marsh areas above MHW. In low populations (i.e., one family of 3 to 5 per hectare), muskrat runs may have a beneficial influence in marsh productivity through the thinning of dense marsh stands

and the increasing of water circulation and exchange.

On a 3-acre 5-year-old marsh establishment site (Garbisch and Woller, Q 5) which was planted to nine brackish water marsh species, muskrats exhibited the following plant preferences for food during the first year: S. cynosuroides > Typha spp. and Scirpus spp. > Phragmites communis > S. alterniflora > S. patens > Distichlis spicata. All S. cynosuroides, Typha spp. and Scirpus spp. were eaten out the first year. In subsequent years, muskrats have selectively fed on two established stands of P. communis, even though S. alterniflora occupies ca. 90% of the marsh surface.

The types of plant stock to be recommended for use in marsh establishment must be carefully considered in light of the available surface elevations at the site, the site's exposure, and the time of planting. Because tidal marsh plant materials have been available from only several registered nurseries, much of the reported marsh establishment work has used plugs or bare root extracts from natural or man-made marshes (see Table 1). If such extractions are supervised properly and carried out according to recommendations (Darovec 1975, Knutson 1977), minor damages to the natural marsh resources may result. Although such practices will continue, they are discouraged for large (one hectare or greater) projects in areas where natural sources of marsh plants are not abundant. Even if transplant materials are removed in checkerboard fashion and with care not to denude those sections being excavated, an adverse impact, introduced particularly by work crews, and to a lesser extent by holding containers and various auxiliary equipment (i.e., water pumps for washing plants), cannot be avoided.

The types of marsh plant stock that are recommended for use under the various site exposures and the various planting times are given in Table 3. Recommendations by Knutson (1977) are similar. The use of plant stock obtained from the immediate region of a site or plant stock developed from plant materials

Table 3. Types of plant stock and recommended planting times.

Use	Bare Root Plants		Dormant		Peat-potted Plants	
	1-month	3-month	Mature	Bare Root Plants	Potted Plants	Age: ^a 3-mo. 5-mo. 7-mo. Seeds
Nursery & Laboratory	X	X	X	X		X
Winter Planting (above MHW or in sheltered areas) ^b				X	X	X
Spring Planting:						
a) sheltered areas ^b		X		X		X
b) moderately exposed areas ^c			X	X	X	
c) exposed areas ^d				X	X	
Summer Planting:						
a) sheltered areas ^b					X	
b) moderately exposed areas ^c					X	
c) exposed areas ^d					X	
Fall Planting:						
a) sheltered areas ^b					X	
b) moderately exposed areas ^c					X	
c) exposed areas ^{d, e}					X	

a) Seedlings. b) Confined areas or less than 1 mi fetch. c) 1-5 mi fetch. d) 5-10 mi fetch. e) Don't plant.

harvested (seeds or sprigs) from this region, is preferred to plant stock originating from more remote locations (Woodhouse, Seneca, and Broome 1976). If practicable, the plant stock used at a marsh establishment site should originate from areas within a 100-mile radius of the site.

Nursery stock in the form of properly developed peat-potted transplant material has been found to provide superior performance to all other plant stock for marsh establishment work (Environmental Concern Inc. 1976); however, Woodhouse, Seneca, and Broome (1976) have not corroborated this. The overriding advantage of peat-potted stock over other plant stock is that the former can be used successfully at almost any time of the year (see Table 3). There are not many multi-contractual construction projects that progress without delays of some sort or another. It is safe to assume that all future marsh establishment projects will not have their sites prepared and available for planting in the spring.

Seeding of S. alterniflora, S. foliosa, P. virginica, and P. cordata appears to be limited to elevations above MTL and preferably the upper 20% of the mean tidal range (Woodhouse, Seneca, and Broome 1976; Environmental Concern Inc. 1976; Knutson 1977; and Garbisch and Coleman 1977). As a rule of thumb, increasing the maturity of nursery transplant materials upon decreasing the elevations in the tidal zone will lead to the greatest survival of transplants and the best overall plant establishment. Important exceptions to this rule of thumb occur (1) throughout the litter deposition corridor and (2) at the high elevation zones at sites experiencing tidal amplitudes in excess of five feet. Extensive deposits of litter and other debris often accumulate throughout the spring and storm tide elevations of natural marshes, particularly salt marshes (see Fig. 1). The marsh in this zone, referred to as the litter deposition corridor, is subject to especially damaging effects of such litter depositions. This zone is an ideal location to design and construct tidal creeks in marsh establishment projects. Such tidal creeks not only will



Fig. 1. Litter deposition corridor in a salt marsh.

increase water circulation throughout the marsh and increase the habitat diversity, they will function as depositories for litter and as optimum environments for the rapid decomposition of the litter and the export of the resulting nutrients.

Marsh establishment throughout the litter deposition corridor may be difficult (see Fig. 1); however, if it is attempted, the most mature plant stock available should be used. This zone may often be suitable for the establishment of marsh shrubs (e.g., Iva frutescens and Baccharis halimifolia) and trees (mangroves), provided that the transplant material is sufficiently developed to withstand the litter depositions.

Another problem with marsh establishment throughout the high elevation zone, particularly in areas subject to tidal amplitudes greater than five feet, is one of water stress during periods of drought. Tidal inundation periods in this zone are short and unless adequate rainfall occurs, surface sediments dry during the interim between successive high tides resulting in high mortalities of seedlings and shallow transplants (Dunstan, McIntire, and Windon 1975; Dieterich, Q 1). Such mortalities can be reduced by using mature peat-potted nursery stock which can be planted 7 to 9 inches deep.

Transplanting, seeding (for S. alterniflora), and fertilizing methods and specifications are available (Darovec 1975; Environmental Concern Inc. 1976; Woodhouse, Seneca, and Broome 1976; and Knutson 1977). To achieve vegetative stabilization of the sediments during the first growing season and uniform vegetative cover during the second growing season, recommended transplant spacings vary from 1 to 3 feet, depending upon the conditions at the site and the plant species. The highest density plantings are recommended for critical area stabilization and for areas subject to high physical stresses. A high degree of cover by well-developed plants will discourage the intrusion of Canada geese to the interior of a newly established marsh and

restrict their feeding to the readily protected seaward marsh fringe (Environmental Concern Inc. 1976). Consequently, if winter Canada geese populations are known to be high in the region of a site, consideration should be given to maximizing the density of transplants.

There are no available or convenient chemical test methods for the determination of available nitrogen and phosphorus in tidal sediments (Woodhouse, Seneca, and Broome 1976). Consequently, fertilizer requirements for marsh establishment are not readily determined. Fertilizations should be conducted, as prescribed, for all marsh establishment work in sand sediments. Fertilization may make the difference between plants becoming sufficiently established to sustain the winter stresses and plants succumbing to such stresses (Garbisch, Woller, and McCallum 1975a). For other sediment types (silt-clay), the options are (1) to plant and then to top-dress fertilize one to two months later if plant development and pigmentations suggest nutrient deficiencies; (2) side-dress fertilize with a slow release fertilizer at the time of planting; or (3) conduct short-term (2-mo) growth tests using site sediments in order to identify the optimum fertilization rate. For mud (silt and clay) sediments when growth tests have not been conducted, Environmental Concern Inc. (pers. comm.) recommends side-dress fertilization with Osmocote slow release fertilizer at the time of planting:

<u>Plant Material</u>	<u>Formulation</u>	<u>Rate</u>	<u>Time of Planting</u>
seed	18-6-12 (8- to 9- mo release)	600 lb/acre	spring
plugs, nursery stock, sprigs	18-6-12 (8- to 9- mo release)	1 oz (41 g)/ plant site	early spring and winter
plugs, nursery stock, sprigs	19-6-12 (3- to 4- mo release)	1 oz (41 g)/ plant site	late spring, summer & fall

Osmocote fertilizer has been found to provide satisfactory results in freshwater, brackish-water, and saltwater locations.

(b) Maintenance and Management. The three principal maintenance and management requirements for marsh establishment are (1) removal of debris and litter depositions, (2) protection against waterfowl depredation, and (3) fertilization (Environmental Concern Inc. 1976, Knutson 1977). In populated urban areas, vandalism appears to be an additional maintenance problem - people pulling out transplants and netting (Teas, Jergens, and Kimball 1975; Dieterich, Q 1-9; Hair and Brunn, Q 2-8).

During the growing season, marine algae (e.g., Ulva lactuca and Enteromorpha spp.), rooted submerged aquatic plants (e.g., Ruppia maritima and Zostera marina), free-floating aquatic plants (e.g., Eichornia crassipes), and sundry debris may be deposited throughout the litter deposition corridor and at lower elevations of a marsh establishment site (Knutson, pers. comm.; Kingsley, pers. comm.; Environmental Concern Inc., pers. comm.; Dodd, pers. comm.; and Dieterich, Q 1-9). If such deposits are massive, the affected marsh may be smothered and permanently lost. Periodic removal of deposited materials should be accomplished, as required, during the first growing season. Initially, biweekly site maintenance trips should be made. Depending upon the need, the frequency of maintenance trips can be subsequently adjusted. Late spring and summer plantings are more vulnerable towards litter depositions than are early spring plantings, and may require more frequent maintenance.

Depending upon the design of the marsh establishment project, and often unavoidably, standing crops of the established and neighboring marshes will become naturally harvested and collect throughout the litter deposition corridor during the winter and early spring months (this appears to be more of a problem for salt marshes than for fresh marshes). This litter should be removed before the marsh resumes growth the following spring. Continued annual spring maintenance would be desirable, but generally would not be practicable.

The annual standing crops on sheltered or confined salt-marsh establishment sites may neither be exported nor be relocated, but slump to the marsh surface suffocating new growth and markedly lowering the marsh productivity the following year (Garbisch and Woller, Q 8-9). This is a maintenance problem that is not easily resolved for large-scale projects, unless controlled burning is feasible and is considered desirable.

If large populations of wintering or migrating geese are known to utilize the region where a marsh establishment site is located, measures to protect the site against excessive depredation should be considered (see Section 2(a)). Low cost enclosures have been found to be effective (Environmental Concern Inc. 1976); however, periodic maintenance of these may be required and such protection may be judged to be necessary for several years or more.

Geese are not the only wildlife despoilers in marsh establishment. Cattle have led to serious management and maintenance problems (Stanley and Hoffman 1974, 1975; Sharp and Vaden 1970); horseshoe crabs (Savage 1972) and blue crabs (Garbisch and Woller, Q 5-10) have destroyed plantings; rabbits (Dodd and Webb, pers. comm.) and possibly coots (Knutson, pers. comm. and Kingsley, pers. comm.) have inflicted notable damage to new plantings in the gulf and west coasts; various insects and crustaceans have caused serious problems in the establishment of Rhizophora mangle (Carlton 1974; Kinch 1975 and Q 21-9); and grasshoppers and crickets have been found to cause serious damage to the seedheads and marked reductions in seed productions of established Spartina salt marshes that abut terrestrial habitats (Environmental Concern Inc. pers. comm.; Newton, pers. comm.). Enclosures can be used effectively to exclude cattle from marsh establishment sites (Stanley and Hoffman 1974, 1975); however, effective management of the other mentioned animals has not been developed. Newton (pers. comm.) has suggested maintaining a 3-meter wide barren strip of land between newly established salt marshes and the contiguous terrestrial land in order to discourage grasshopper entry to the

marsh.

The necessity for continued fertilizations of established marshes will depend upon the degree of wave stress that they are subject to. Wave stress is a limiting factor for salt marsh (Garbisch and Woller, Q 5-10; Garbisch, Woller, and McCallum 1975a) and fresh marsh (Garbisch and Coleman 1977) establishment. Often the annual fertilizations of areas of established marshes that are subject to high wave stress will make the difference between the marsh enduring or succumbing to the stress (Environmental Concern Inc. 1976). The need for continued fertilization maintenance can be determined through periodic qualitative (visual) comparisons of the productivities of established marshes with those of neighboring natural ones; however, in high wave energy areas, such need should be anticipated.

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APPENDIX B

of

WES CONTRACT REPORT D-77-3

RECENT AND PLANNED MARSH
ESTABLISHMENT WORK THROUGHOUT THE
CONTIGUOUS UNITED STATES
A SURVEY AND BASIC GUIDELINES

by

E. W. Garbisch

INCL 3

APPENDIX B: MARSH CREATION RESEARCH INFORMATION REQUEST

The following pages contain the completed information request (listed verbatim) obtained from those correspondents (listed in Appendix A) who completed and returned the information request forms.

This current and frequently unreported information was acquired by personal interviews (visit, letter, or phone) with people who, during the period of May 1975 through January 1977, have been identified as potential sources of marsh establishment information.

Abbreviations used in the forms include: MHW - mean high water; MTL - mean tidal level; MLW - mean low water; and C & CG Chart - Coast and Geodetic Survey Chart.

No. 1

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MIL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name:

WETLANDS RESTORATION

2. Institution and its address:

TOWN OF HUNTINGTON - DEPT. OF ENVIRONMENTAL PROTECTION
140 E. Main St.
Huntington, NY 11743

3. Persons directly responsible for the project and their respective office telephone numbers:

Mr. Kenneth B. Frenke (516-421-1000, Ext. 277)

4. Interviewee(s) — person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.

Miss. Janet Dieterich

5. Agency(ies) funding the project:

TOWN OF HUNTINGTON - DEPT. OF ENVIRONMENTAL PROTECTION
140 E. Main St.
Huntington, NY 11743

6. Dates of initiation and, if applicable, completion of the project:

I.	Centerport Beach	5/74
II.	Centerport Pond	7/74
III.	Huntington Harbor Yacht Club	9/74
IV.	Centerport Dam	9/74
V.	Huntington Harbor East	5/75
VI.	Gold Star Battalion	6/75
VII.	East Beach Sandspit	6/75
VIII.	Price Bend	8/75

7. Site description

- (a) Site location (C & CG Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

C & CG Chart #224

within the area N 40°53' to N 40°56'

W 73°22' to W 73°28'

(See enclosed map for specific locations)

- (b) Is site a dredged material disposal, a natural area or other? If other, please describe.

Site locations are all natural except "I". Thirty years ago, the original wetland was buried with dredge spoil. Though much of the spoil is gone, marsh area has not returned to former boundaries.

- (c) Are the sediments at the site unconfined and unprotected?

Unconfined and unprotected by any man-made structures.

- (d) If sediments at the site are either protected or confined, what structures and materials were used?

NA

- (e) Are areas involved in marsh creation?

All the sites are inundated with regular semidiurnal tide frequency except "II". Centerport Pond is left filled Friday evening to Monday morning. It is regularly flushed the other five days.

- (f) Physical characteristics of sediment.

	<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>	<u>V</u>	<u>VI</u>	<u>VII</u>	<u>VIII</u>
Sediment & clay	X	XX	X	X	X	-	X	-
Sand	XX	X	X	X	X	X	XX	XX
Pebbles	-	-	X	-	-	-	-	-

- (g) What is the sediment chemical composition?

In core samples taken at site "I" range 25-50% carbon; .01% nitrogen, .01% phosphorus.

- (h) The range (in degrees) of the surface slopes at the site, the dominant slope, how were the slopes achieved?

<u>natural grading</u>	<u>range</u>	<u>dominant</u>
I	3-15%	3-5%
II	0-3%	0-2%
III	2-10%	2-5%
IV	5-10%	5-10%
V	3-10%	3-5%
VI	3-5%	3-5%
VII	5-10%	5-10%
VIII	3-10%	3-5%

- (i) What are the major fetch lengths and directions?

Although there is a 20 mile fetch coming across the sound from Connecticut in a N-NW direction, the sand spit (at N^{40°56'} W^{73°24'}) takes the impact of wave energy generated in the last few years.

- (j) What wind directions prevail and dominate? During what months are the dominant winds encountered?

N-NW is the dominant wind particularly during the winter, in the last few years.

- (k) What is the mean lunar tidal amplitude at the Site? Are wind influences on the tide significant?

The mean lunar tidal amplitude is in the range of 7-7½ ft. Due to the sand spit, the wind influence on the tide is insignificant.

- (l) What is the chemical composition of the receiving water at the site (annual salinity range and any known constituents that are present in unusually high concentrations)?

Range of salinity is 23-26%

- (m) Were there any site preparation requirements?

NA

- (n) Problems associated with the site preparation.

NA

- (o) Please provide recommendation, if any, for site preparation based upon experience.

Kenneth Frenke has already discussed his comments with you, both at Maryland and here on Long Island.

- (p) Any additional information and comments that you feel might be helpful for future site selections and preparation.

See above

8. Marsh creation description:

- (a) What are the principle objectives?

1. to stabilize the eroding sand spits
2. to filter runoff entering the harbors
3. to create breeding areas for small fry and invertabrates.
4. to construct natural habitats for migratory and stationary wildlife.
5. to establish natural study areas for educational purposes.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, springs, rhizomes, seedlings, (potted, bare root, age), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL + mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

Since there are so many sites to consider, Table 1 was expanded for simplicity. Table 1 is on page B8.

- (c) Endemic plant stock was or was not used. If "was not used" indicate geographic origins of various stock used.

The planting material came from New York and Virginia.

- (d) If plant stocks were purchased, what were the sources?

Environmental Concern, Inc.

- (e) What mechanisms were employed for planting?

Shovels, mechanical augers, tractors and planters, were all used at Centerport Beach. Only shovels were used at the remaining sites.

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1)

All Spartina alterniflora received same fertilizer mixture which consisted of a 5:1 ratio of Ammonia nitrate and super phosphate. The fertilizer was applied manually around the base of each individual plant.

General rule - all 4 month old plants received 1 oz;
< 4 months received $\frac{1}{2}$ oz during the first year of establishment. The following year each mature plant received one ounce.

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (biomass determination results, etc.) in the following Table. Please list references to available published material (on project) not given in Table 3.

- (b) What problems have been encountered with regard to vegetative establishment?

1. Plants did relatively well the first year of establishment, however they didn't grow to expected peak and fertilizer had to be applied the following year.
2. Tidal action caused erosion around plants and some were washed out.
3. Geese uprooted and fed on vegetation.
4. Ulva buried and killed plant seedlings.

- (c) The problems listed in 9 (b) have been resolved by:

1. Consecutive year of fertilizer.
2. Selection of planting sites on less gradient slopes. Individual plants are buried deeper in soil where greater tidal action is expected.
3. Geese problem insignificant.
4. Manual removal of ulva first year of growth.

- (d) Wildlife have utilized created marsh areas and wildlife management problems do not exist.

There appears to be an increase in sightings of wildlife since the recreation and extension of wetlands. However amount of vegetation damaged is minor and not considered a significant problem.

- (e) Insect problems are not significant.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age) etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

TE	CODE	PLANT SPECIES	PLANT STOCK	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
	A	<u>Spartina alterniflora</u>	Potted seedlings (4-6 months)	MLW-MTL	5/74
	B	" "	Potted seedlings (2-3 months)	MTL-MHW	
	C	" "	Potted seedlings (2½-3 months)	MLW to MTL	8/74
	D	" "	Potted dormant (2-2½ months)	MTL	4/75
	E	" "	Bare Root (2-2½ months)	1' < MTL > 1'	5/75
	F	<u>Spartina patens</u>	Sprigs	MHW to +1	5/75
I	G	<u>Spartina alterniflora</u>	Potted seedlings (3-4 months)	MTL to MHW -1'	7/74
II	H	" "	Potted seedlings (2½-3 months)	1' < MTL to MHW -1'	9/74
IV	I	" "	Potted seedlings (4 months)	MTL to MHW -1'	9/74
	J	" "	Bare root (2-2½ months)	MLW - MHW	5/75
	K	" "	Potted seedlings (2-2½ months)	MLW -MHW	5/75
VI	L	" "	Potted seedlings (4-6 months)	MTL - MHW	6/75
VII	M	" "	Potted seedlings (2-2½ months)	MTL to MHW - 1	6/75
VIII	N	" "	Potted seedlings (4-5 months)	MTL +1 to MHW -2	8/75

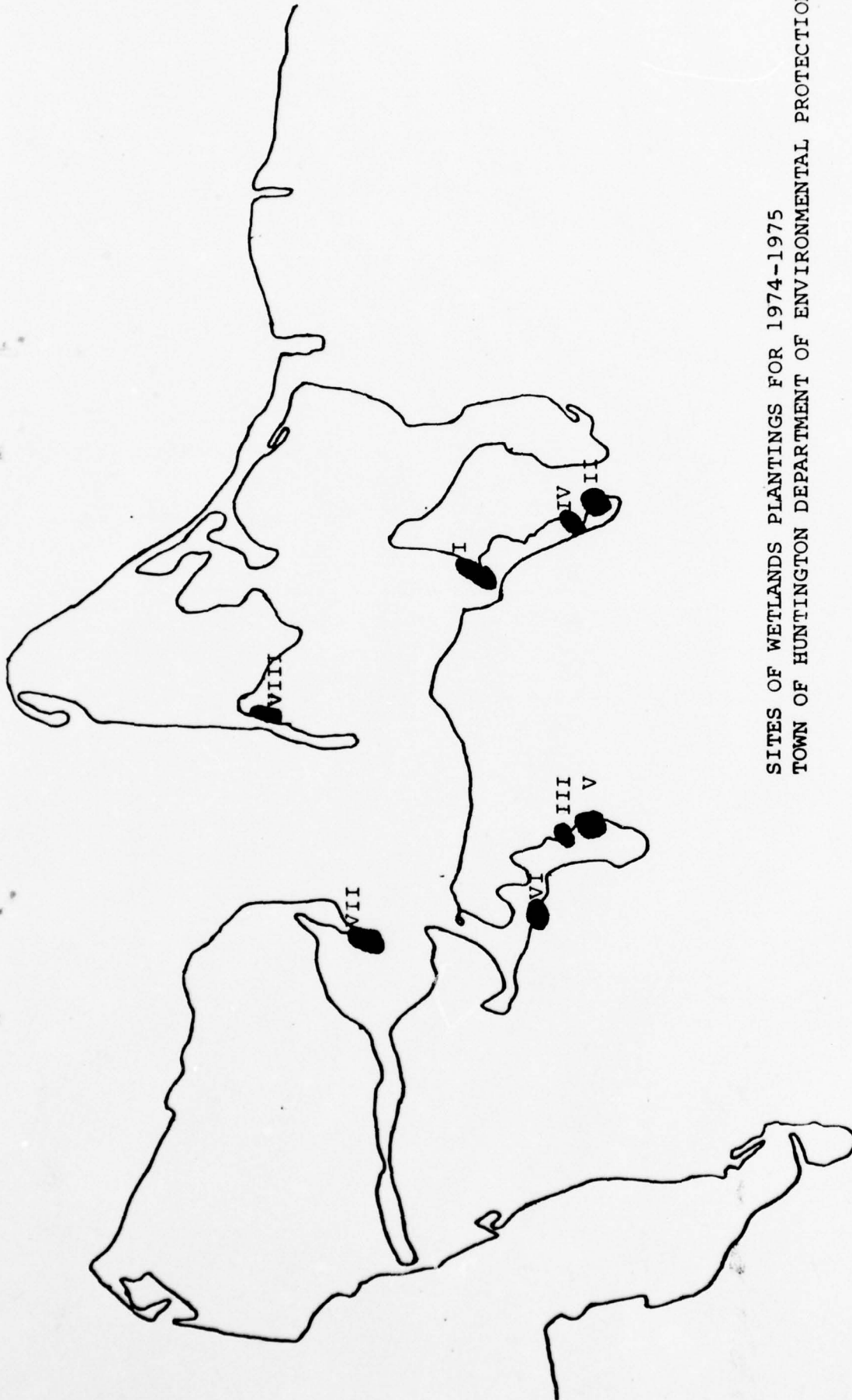
TABLE 2

<u>SITE</u>	<u>CODE</u>	<u>DATES OF APPLICATION</u>
I	A	7/74, 8/74, 7/75, 8/75
	B	7/74, 8/74, 7/75, 8/75
	C	7/75, 8/75
	D	7/75, 8/75
	E	7/75, 8/75
	F	-
II	G	-
III	H	7/75, 8/75
IV	I	7/75, 8/75
V	J	7/75
	K	-
VI	L	7/75, 8/75
VII	M	None
VIII	N	None

TABLE 3

CODE	RESULTS
I	<p>Since it was the first planting, experimental sites with various strata, slope gradients and two types of plant stock were used. The young plants (B) along MHT zone did poorly. There was an exceptional bloom of Ulva in our harbor and many of the seedlings were buried. 20% of the original plant material was lost to the shifting of wind direction and sand movement. Some of our plants were also washed out by tidal action. The type of soil the plants were grown in did not have as much impact on the success of the plantings as did the location of the plants in relation to the tidal zones.</p> <p>(C, D, E) Planted in areas of washout and along the open area of sand bar did relatively well. 25% of fatalities due to tidal action and sand movement.</p> <p>(F) 40% of sprigs survived; location was not the best suited for the vegetation.</p>
II	(G) Due to inconsistently flushing and inundation, all of the vegetation died with a few exceptions.
III	The fatality of 25% was due to their location - too near to MLW.
IV	25% loss due to location - too near MLW and tidal action.
V	<p>(J) At least 75-80% viable.</p> <p>(K) 100% fatality; plants were uprooted by people in the neighboring area and piled above MHW. By the time we were notified and replanted the vegetation at another site, it was too late.</p>
VI	Vegetation is doing quite well, 100% successful.
VII	100% successful planting
VIII	100% successful planting

SITES OF WETLANDS PLANTINGS FOR 1974-1975
TOWN OF HUNTINGTON DEPARTMENT OF ENVIRONMENTAL PROTECTION





TOWN OF HUNTINGTON

LONG ISLAND, NEW YORK

KENNETH C. BUTTERFIELD, SUPERVISOR

DEPARTMENT OF ENVIRONMENTAL PROTECTION

August 23, 1976

Dr. Edgar Garbisch
Environmental Concern
P.O. Box P
St. Michaels, Maryland 21663

Dear Dr. Garbisch,

As per your request, here is the updated information on our wetlands plantings:

1.-5. NA

6. This years sites were concentrated at Sand City.

IXa Cove east of spit
IXb East side of revetment

7. Site description

- a. Locations are on enclosed map
- b. At site IXa the S. patens was planted on loose sand fill
- c. & d. Since sites are on east side of spit, they are naturally protected from the brunt of the northwesterlys.
- f. Site IXa & b (along the east side of the revetment) consists of sand and pebbles - average $\frac{1}{2}$ - $\frac{3}{4}$ " diameter. Site IXa (along the east side of cove and tip of smaller spit) is composed of sand and stones averaging 2" in diameter, much more organic compositions.

	(IXa&b)	(IXa)
Sediment		X
Sand	X	X
Pebbles	X	X

h. Surface slopes

grading	range	dominant
IXa*	3-10%	5-8%
IXb	3-5 %	

*one area of IXa in northwest corner of cove has a 15% slope.

NOTE: correction in original Site I range should be 3-5%, not 3-15%.

i. Major fetches

The 1 mile fetch generated by the occasional S-SE winds does not have much impact on the area.

8. Marsh creation description:

- a. The principle objective of this year's projects were to reverse the erosive movement of sand to one of rebuilding and refortification through the establishment of vegetation.
The cove is also expected to become an excellent area for breeding of small fry and invertebrates.

b.	<u>Site</u>	<u>Date</u>	<u>Code</u>	<u>Vegetation</u>	<u>Plant Stock</u>	<u>Elevation</u>
	I	4/76	F	<u>S. patens</u>	Sprigs	MHW + 1
	IX	4/76	O	<u>S. patens</u>	Sprigs	MHW + 1
		5/76	P	<u>S. alterniflora</u>	Bareroot	MLW to MTL
		5/76 & 7/76	Q	<u>S. alterniflora</u>	4" pots	MTL to 1- MHW

c, d, & e. See last year's report

- f. Sites I, VI, VIII and IX were fertilized over this year. The new vegetation received $\frac{1}{2}$ dosage while the older sites received 1 oz./plant.

9. Marsh creation results:

- b. Most of the problems that were cited last year have either been solved or cease to be a significant problem. However, the second year of growth is not as good as expected.

RESULTS

I (F & F₁)

The Spartina patens, that did survive last year, in addition to this year's plantings were growing satisfactorily, many were flowering. However, Hurricane Belle caused massive sand shifts along the smaller spit and all the S. patens, as well as sections of the S. alterniflora have been buried.

IX (O) The S. patens were unable to establish on the loose sandy slope in the NW side of the cove. Most of the vegetation was lost. Due to seaweed and debris accumulation more S. patens died. Only 30% survived after Hurricane Belle swept through.

IXa (P & Q) Originally the cove had been sectioned off for the various types of container grown plants. However, due to the considerable movement of sand along the sloping shoreline within the cove, many of the small bareroot material had been buried. In an attempt to "fill-in" vacant areas, the following shipment of 4" pots became interspersed with the bareroot. Therefore it is not possible to rate the mortality of the previous plants.

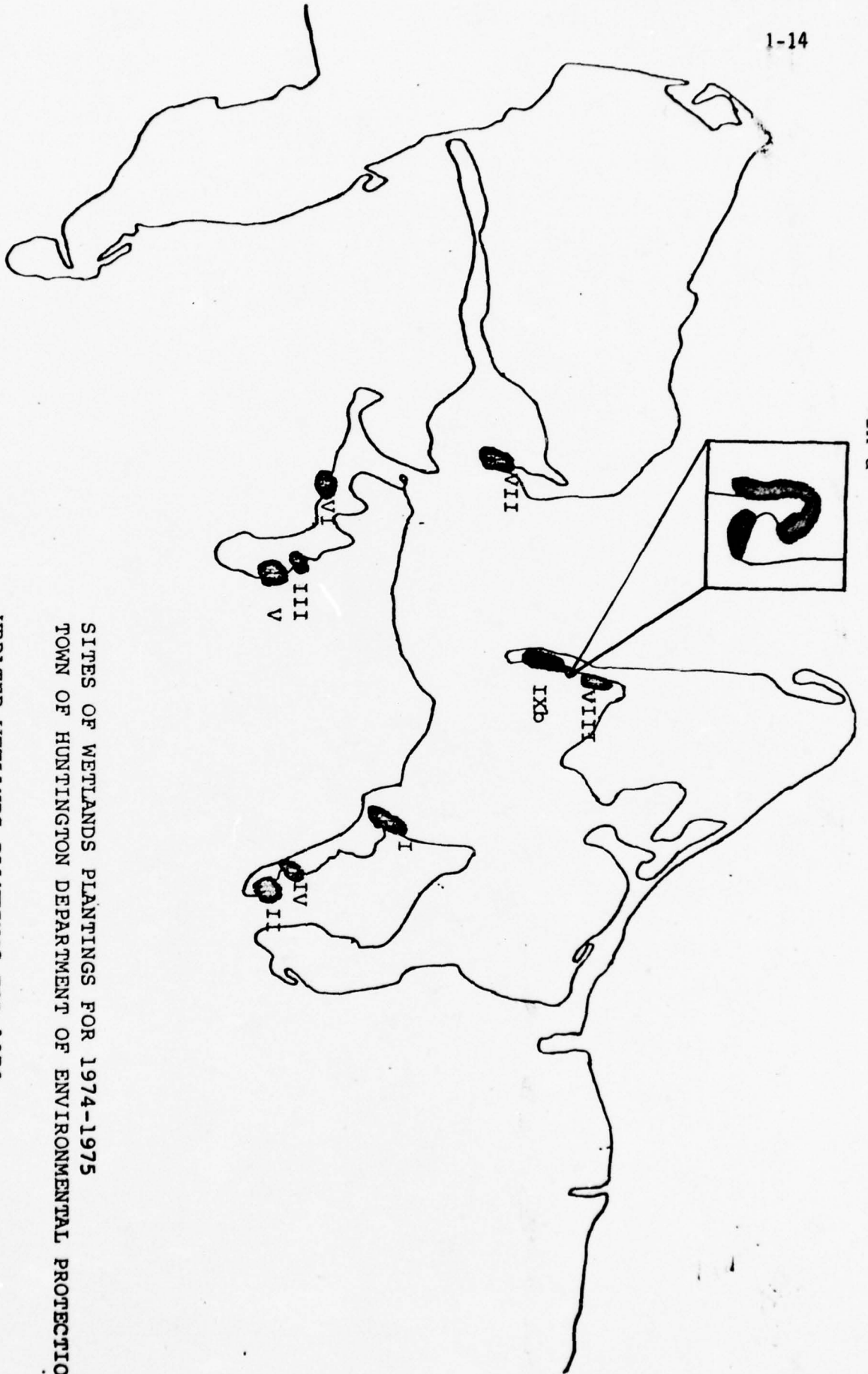
As of now, the plants are well established and weathered Hurricane Belle quite well; perhaps 5-10% fatality.

IXb Prior to Hurricane Belle, 90% of the 6 month old plants were healthy along the east side of the revetment. After the hurricane, the plants along the bottom third are quite weathered. Many of the blades of grass are snarled and wrapped around their base, others are just cut off at the soil line. It is difficult to estimate the actual percentage of survivors.

Going south to north the condition of plants improve greatly. The plants in the top third are still green and healthy.

Excluding the south section, 80% of plants are continuing to grow successfully.

IX a



SITES OF WETLANDS PLANTINGS FOR 1974-1975
TOWN OF HUNTINGTON DEPARTMENT OF ENVIRONMENTAL PROTECTION
UPDATED WETLANDS PLANTINGS FOR 1976

No. 2

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Sand Island, Great South Bay, Town of Islip, New York - Area: approximately 35 acres (pg. 6 of attached report)
2. Institution and its address: Town of Islip, Department of Environmental Control, 577 Main Street, Islip, NY 11751
3. Persons directly responsible for the project and their respective office telephone numbers:
Dr. Malcolm E. Hair, Marine Resource Consultant (516)581-2000, Ext. 309
Ms. Elsa Brunn, Natural Resource Biologist
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
Same as # 3
5. Agency(ies) funding the project:
Town of Islip, Department of Environmental Control

6. Dates of initiation and, if applicable, completion of the project:

Initiated November 1973

Anticipated Completion - October 1975

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

C&GS Chart No. SC-120

- (b) Is site a dredged material disposal area ☒, a natural area ☐, or other ☐? If other, please describe.

- (c) Are the sediments at the site unconfined and unprotected ☒ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

unconfined

- (e) Are areas involved in marsh creation regularly ☒, occasionally ☐, seldom ☐, always ☐, inundated? Check one or more.

- (f) Are physical characteristics of sediment mud (silt and clay) ☐, sand ☒, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

No specific analysis performed but material consists of clean, well scoured sand from channel areas

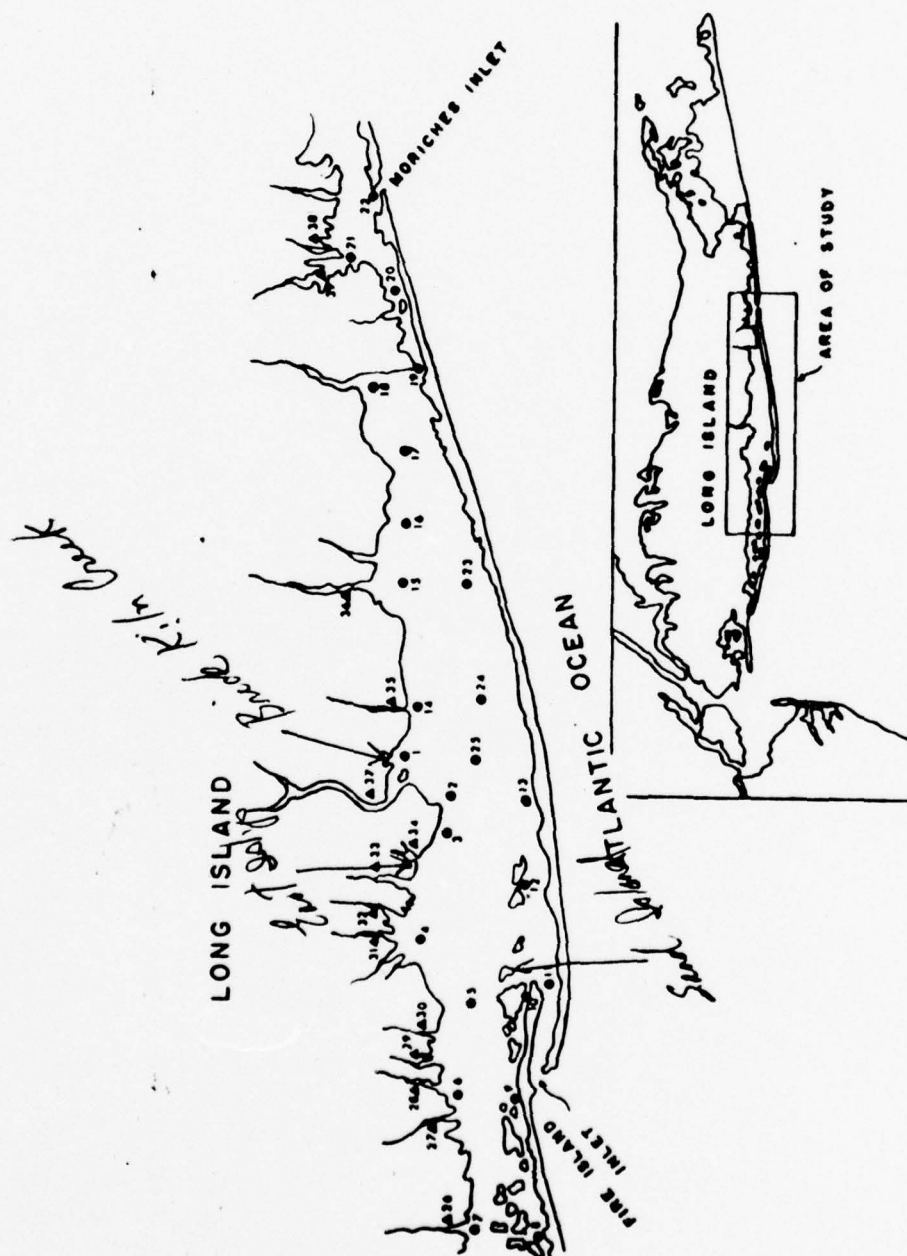


Fig. 1: General location of Great South Bay showing sampling station. Circles = bay stations; triangles = river stations.

- (h) What is the range (in degrees) of the surface slopes at the site? Slopes of shorelines are 1:25' What is the dominant slope?

How were the slopes achieved (e.g. natural or bulldozer grading)? All slopes achieved by allowing hydraulically pumped material to settle to desired elevations

- (i) What are the major fetch lengths and directions? Dominant fetch is from northeast in winter app. 5 miles. Longest fetch is from east app 20 miles. Dominant fetch in summer is from south-southwest, app. 1 mi

- (j) What wind directions prevail and dominate?

During what months are the dominant winds encountered?

Winter prevailing & dominant winds from N/NE - average 10-20 mph

Summer prevailing winds from south-southwest - average 5-10 mph

- (k) What is the mean lunar tidal amplitude at the site?

Are wind influences on the tide dominant ☒, significant ☐, insignificant ☐?

approximately 1½ feet

- (l) What is the chemical composition of the receiving water at the site (annual salinity range and any known constituents that are present in unusually high concentrations)? Average salinity 280/00, range 27-300/00, see attached report for detailed description of nutrients at this and other sites in Great South Bay

- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally. The only restriction on site preparation was the maintenance of a 1:25' slope in the intertidal zone

- (n) If there were any problems associated with the site preparation, please describe. No problems encountered during hydraulic pumping

- (o) Please provide recommendations, if any, for site preparation based upon experience. A minimum of a 25' intertidal zone was found necessary for plants to become established and stabilize the shoreline

- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations. The time of the dredge and fill operation should be scheduled as close to the best time for planting if dewatering problems are not encountered. If this is not possible, temporary stabilization using Vexar netting should be carried out until plants have established themselves. We have used this material with excellent results in both the intertidal and supratidal areas
8. Marsh creation description:

(a) What are the principle objectives? Principle objective of the project was to attempt to reduce the frequency of maintenance dredging of adjacent channels by presently shifting sands and dredged materials from moving back into the dredged areas while simultaneously creating new wildlife habitat. A second objective was to determine the effectiveness of plastic netting as a temporary stabilizing agent.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age) etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Spartina alterniflora</u>	Seedlings in peat pots	MLW - MHW	July 1974
B	<u>Ammophila breviflora</u>	Single culms/hole	MHW + 25	November 1973
C	<u>Ammophila breviflora</u>	Multiple culms/hole	MHW + 25	November 1973 Feb, Mar, April 1974
D	Japanese Black Pine	Bare root seedlings in 4" peat pots	MHW + 25	March 1974
E	<u>Rosa multiflora</u>	Bare root seedlings	MHW + 25	May 1974
F	<u>Rosa rugosa</u>	Seedlings potted in mulch	MHW + 25	May 1975
G	<u>Spartina alterniflora</u>	6" seedlings in 1½ peat pots	MLW - MHW	May - June 1975
H	Purple willow	1' stringers	MHW + 25	May - June 1975
I				

- (c) Endemic plant stock was ☐ was not ☒ used. If "was not used," indicate geographic origins of various stock used.

- (d) If plant stocks were purchased, what were the sources?

Spartina - Environmental Concern

Rosa rugosa - Pachysandra Nursery, Sayville, New York

All others - New York State Dept. of Environmental Conservation

- (e) What mechanisms were employed for planting?

Spartina alterniflora - 1' centers in 4" peat pots - hand planted

Ammophila breviflora - 3' centers bare culms - hand planted

All others - clumps or groupings - hand planted

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A	Fairway fertilizer 30-10-30	Hand broadcast app. 25 lbs/acre	Surface
B			
C	Scavenger plant sewage sludge & soil (1:1)	Applied at base of culms	Surface
D			
E			
F	Fairway fertilizer 30-10-30	Hand broadcast around base	Surface
G	Fairway fertilizer 30-10-30	Hand broadcast app. 25 lbs/acre	Surface
H	Fairway fertilizer 30-10-30	Hand broadcast around base	Surface
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	Plantings were carried out too late in growing season to obtain quantitative data. Qualitatively, plants have survived (approx 85%) and have developed large root systems
B	Excellent results in areas planted with multiple culms/hole. Areas planted with single culms are stabilized but individual plants are still apparent. Fertilizer worked very well but unsatisfactory from a microbiological standpoint (health problems)
C	Single culm plantings gave rise to 10-18 new stems. Multiple culm plantings gave rise to 32-37 new stems.
D	Plants seem to have survived winter fairly well (approx. 70% survived) Two year seedlings did much better than first year plants.
E	Plants have died back to ground level but root systems are now producing new plants. Mulching with algae and eelgrass to increase moisture content appears to help.
F	Plants going in in May 1975 - no results to date
G	Plants going in in May 1975 - no results to date
H	Plants going in in May 1975 - no results to date
I	

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?
Main problem has been with vandalism as site especially in areas stabilized with Vexar netting. Second problem is logistics in working on an island (transportation of personnel & equipment).
- (c) The problems listed in 9(b) have ☒ have not ☒ been resolved.
If the problems have been resolved, please describe the solutions.
Main problem is one of educating public & enforcement procedures - not solved. Second problem solved with construction of special vessel & rafts.
- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☒ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?
- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?
- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site. The main considerations in dealing with unconfined dredged material is 1) the dredging in relation to the growing season. If the spoil cannot be stabilized with vegetation before being exposed to winter storms, some temporary means of stabilization such as the use of plastic netting is required. We estimate that 0.63 cu. ft. of sand per linear foot of beach per day was lost in unstabilized areas due to wind erosion. 2) The site preparation and dredging operation should be reviewed by a biologist familiar with marsh creation and shoreline stabilization techniques. This solves a great many problems which can arise later if only engineering requirements are considered in the initial planning. 3) Whatever temporary measures are used they should be inexpensive, easy to install, suitable for use on island sites and nonpolluting. The closest we have come to achieving these goals is the use of plastic netting.

No. 3

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: East Islip Marina, East Islip, Long Island, New York, see page of attached report - approximately 30 acres.
2. Institution and its address: Town of Islip, Department of Environmental Control, 577 Main Street, Islip, New York 11751
3. Persons directly responsible for the project and their respective office telephone numbers: Dr. Malcolm E. Hair, Marine Resource Consultant and Ms. Elsa Brunn, Natural Resource Biologist - 516-581-2000, Ext. 309
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
Same as #3.
5. Agency(ies) funding the project: Town of Islip, Department of Environmental Control.

6. Dates of initiation and, if applicable, completion of the project:

Dredging and spoil deposition completed approximately 20 years ago. Revegetation project initiated June, 1974. Anticipated Completion - October 1975.

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

C & GS Chart No. SC-120 - see page 6 of attached report.

- (b) Is site a dredged material disposal area ☒, a natural area ☐, or other ☐? If other, please describe.

Dredged material deposited on salt marsh - presently a Town Recreation facility.

- (c) Are the sediments at the site unconfined and unprotected ☒ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

Unconfined.

- (e) Are areas involved in marsh creation regularly ☐, occasionally ☐, seldom ☒, always ☐, inundated? Check one or more.

- (f) Are physical characteristics of sediment mud (silt and clay) ☐, sand ☒, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)
No specific analysis performed - material consists of clean bay bottom fine sand - site has been laying fallow approximately 20 years.

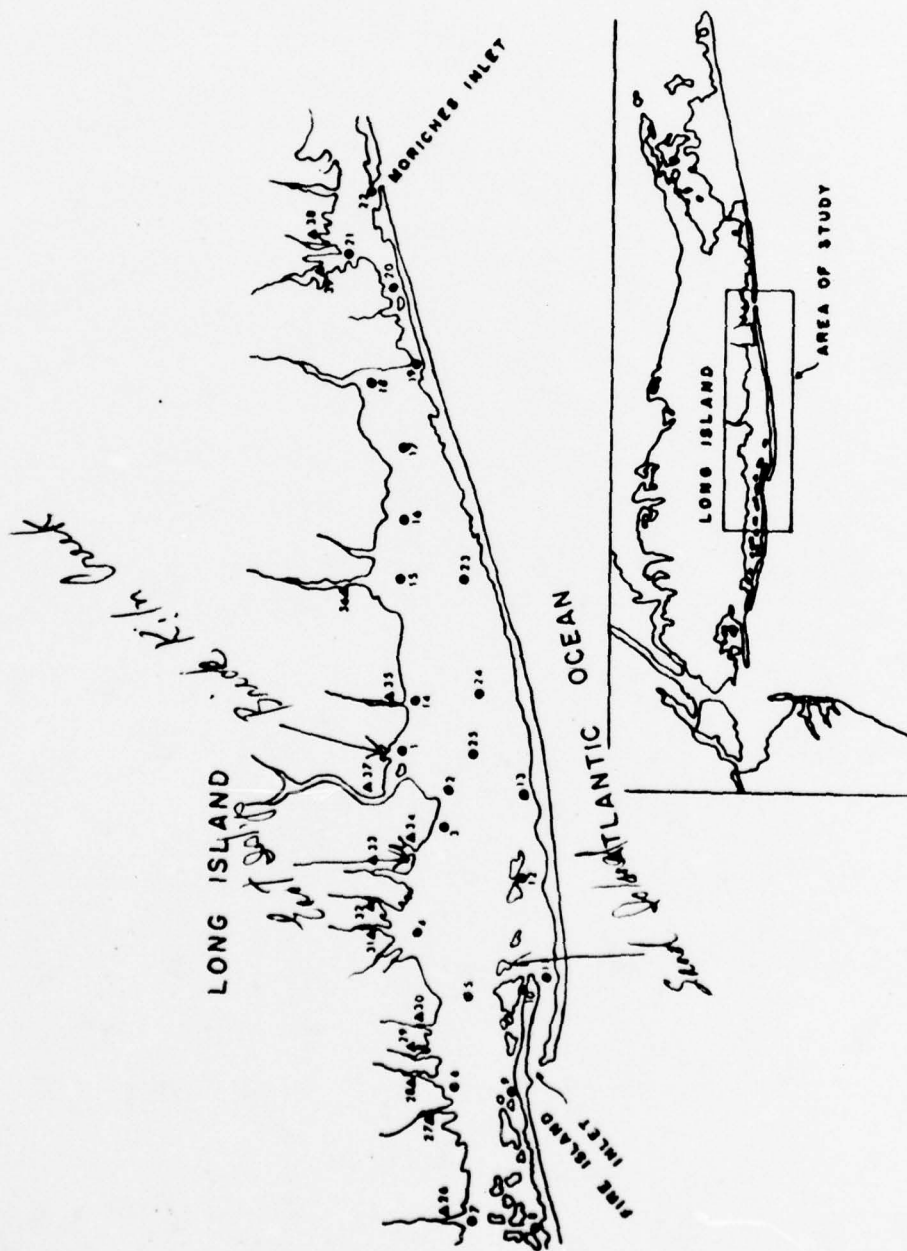


Fig. 1: General location of Great South Bay showing sampling station. Circles = bay stations; triangles = river stations.

- (h) What is the range (in degrees) of the surface slopes at the site?

What is the dominant slope?

How were the slopes achieved (e.g. natural or bulldozer grading)? Material deposited fairly evenly over salt marsh approximately 2-3 feet thick - material hydraulically pumped and allowed to settle to present elevation (3-7 ft above MHW)

- (i) What are the major fetch lengths and directions?

No fetch - entire site is above MHW

- (j) What wind directions prevail and dominate?

During what months are the dominant winds encountered?

Winter prevailing and dominant are N/NE average 10-20 mph

Summer prevailing from S/SW - average 5-10 mph

- (k) What is the mean lunar tidal amplitude at the site?

Are wind influences on the tide dominant ☐, significant ☐, insignificant ☐?

No tidal influence

- (l) What is the chemical composition of the receiving water at the site (annual salinity range and any known constituents that are present in unusually high concentrations)?

Salinity of underlying water varies with rain & tide. Average 5-70/c

- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally.

No known restrictions at time of original dredging. Site preparation in June 1974 involved bulldozing overburden of sand into a kidney shaped berm down to top of peat. Ground water then entered and created a pond.

- (n) If there were any problems associated with the site preparation, please describe.

No problems

- (o) Please provide recommendations, if any, for site preparation based upon experience.

Similar sites with sand on old peat should be prepared in early spring to minimize wind erosion of the sand until vegetation has grown enough to stabilize the substrate.

- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.

Ponds can be maintained mosquito free by stocking with Gambusia sp.

8. Marsh creation description:

- (a) What are the principle objectives? Principle objective was to reclaim old spoil material and create a freshwater pond stabilized with vegetation. Secondary objective was to incorporate this area into a wildlife preserve.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Ammophila breviligulata</u>	Bare culms	MHW to + 3-7	May 1975
B	Purple willow	Sprigs	MHW to + 3-7	May 1975
C	<u>Rosa rugosa</u>	Seedlings	MHW to + 3-7	June 1974 May 1975
D	Japanese Black Pine	Seedlings	MHW to + 3-7	June 1974 May 1975
E	Bayberry	Sprigs	MHW to + 3-7	May 1975
F	<u>Typha sp.</u>	Plugs	MTL - MHW	June 1974 May 1975
G	<u>Scirpus sp.</u>	Plugs	MTL - MHW	June 1974 May 1975
H				
I				

- (c) Endemic plant stock was ☒ was not ☐ used. If "was not used," indicate geographic origins of various stock used.

- (d) If plant stocks were purchased, what were the sources?

Typha, Scirpus, and Ammophila dug locally

Rosa rugosa - Pachysandra Nursery, Sayville, New York

All others - New York State Dept. of Environmental Conservation

- (e) What mechanisms were employed for planting?

All hand planted

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A	Fairway 30-10-30	Hand broadcast app. 25 lbs/acre	Surface
B			
C	Fairway 30-10-30		Applied to pots before planting
D	Fairway 30-10-30		Applied to pots before planting
E			
F			
G			
H			
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	Plants doing well (approximately 85% survived) Too early for quantitative results
B	All plants growing well; 2-3 new shoots/plant in one month
C	Plants put in June 1974 are doing well Too early for results from 1975 plantings
D	Plants appear doing well Too early for quantitative results
E	Approximately 70% survived Too early for quantitative results
F	Plants from 1974 doing well - producing new shoots Too early for results from 1975 plantings
G	Plants from 1974 doing well Too early for results from 1975 plantings
H	
I	

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?

- (c) The problems listed in 9(b) have ☒ have not ☐ been resolved. If the problems have been resolved, please describe the solutions.

- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☒ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?

- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?

Pond stocked with Gambusia sp. and Fundulus sp.

- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

The peat bog below the spoil must not be broken through in the bulldozing operation. Operation appears to be a good method for restoring wildlife habitat to saltmarshes covered with spoil material. Depth to the groundwater is important in determining whether area will become a standing pond or freshwater marsh.

TOWN OF ISLIP



BARRY D. ANDRES
COMMISSIONER

577 MAIN STREET
ISLIP, N.Y. 11751
581-2000
EXT. ~~KMX~~ 309

DEPARTMENT OF ENVIRONMENTAL CONTROL
ENVIRONMENTAL MANAGEMENT DIVISION

January 10, 1977

Dr. E. Garbisch
Environmental Concern
P. O. Box P.
St. Michaels, Maryland 21663

Dear Dr. Garbisch:

We hope that you have spent a happy holiday season and are looking forward to a successful New Year.

In response to our phone conversation January 5, 1977, I am sending you the following comments concerning the Town of Islip's "Marsh Creation" sites. I hope they are of some assistance to you in writing your report. Please call us if you have any questions.

During July of 1976 approximately 10,260 Spartina alterniflora seedlings (3 plants to each peat pot) were planted on Sand Island, covering an estimated 6,400 square feet of intertidal zone. Pots were planted on 1.5 foot intervals. Unfortunately, we will not be able to evaluate their survival until the next growing season.

We were unable to obtain the necessary equipment and manpower to prepare the Brick Kiln Creek site for planting during 1975. We plan on trying again this year.

All the plantings at the East Islip Marina are doing well with the exception of the Ammophila breviqulata which had been planted on the berm surrounding the pond. It appears that someone has driven a dune buggy or a similar vehicle around the top of the berm at night and has succeeded in killing off most of our Ammophila plantings. We are attempting to make the pond less accessible to vehicular and pedestrian traffic. When this is accomplished we will replant the berm. No planting was carried out at this site during 1975.

Very truly yours

Elsa Brunn

Elsa Brunn
Environmentalist II

EB/am

No. 4

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name:
Restoration and creation of Tidal Marshes with dredged spoil -
North Line Island
2. Institution and its address:
Town of Hempstead
Department of Conservation & Waterways
1 Parkside Drive
Point Lookout, N.Y. 11569
3. Persons directly responsible for the project and their respective office telephone numbers:
Commissioner Harold F. Udell - 431-9200
John D. Zarudsky - 431-9200
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.

Harold F. Udell, Commissioner
John D. Zarudsky
5. Agency(ies) funding the project:

Town of Hempstead

6. Dates of initiation and, if applicable, completion of the project:

The cause of the project - construction of the Wantagh Sewer Line began in 1972. Preliminary reduction in spoil height elevation was done in 1973. Final grading to Mean High Water preparatory to planting was carried out in 1974. Project continuing.

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

ATTACHED

- (b) Is site a dredged material disposal area ☒, a natural area ☐, or other ☐? If other, please describe.

- (c) Are the sediments at the site unconfined and unprotected ☒ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

Not applicable

- (e) Are areas involved in marsh creation regularly ☐, occasionally ☒, seldom ☐, always ☐, inundated? Check one or more.

- (f) Are physical characteristics of sediment mud (silt and clay) ☐, sand ☒, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

95+% Sand

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

NO ₃	P	[%] Volatile Solids
< 10 lbs./acre	< 8 lbs./acre	Av. .37

WANTAGH

4-3



Site

B35

- (h) What is the range (in degrees) of the surface slopes at the site?
 What is the dominant slope?
 How were the slopes achieved (e.g. natural or bulldozer grading)?
 Areas are essentially flat or with minimum slope.
- (i) What are the major fetch lengths and directions?
 2,200' SW 1500' NW
- (j) What wind directions prevail and dominate?
 During what months are the dominant winds encountered?
 March - April NW July - August SW
- (k) What is the mean lunar tidal amplitude at the site? 3.6'
 Are wind influences on the tide dominant \bar{f} , significant \bar{X} , insignificant \bar{f} ?
 Produces wave action on site.
- (l) What is the chemical composition of the receiving water at the site (annual salinity range and any known constituents that are present in unusually high concentrations)?
 Sal. 27.9-34.3 ppt; Reactive Nitrate (ug-at N/l) - Aver. of 4.58 and 11.87. Reactive Phosphate (ug-at P/l) - Aver of 1.50 & 1.37.
- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally. Yes
 Site graded to approximately Mean High Water
- (n) If there were any problems associated with the site preparation, please describe.
 Movement of large volumes of spoil material during grading.
- (o) Please provide recommendations, if any, for site preparation based upon experience.
 Accessory canals dug by dredge into spoil area equidistant to one another to facilitate pushing of fill minimal distances into these canals by bulldozer. Canals left partially unfilled to allow for tidal circulation.
- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives? Most productive use of spoil material; to create new marshes, to replace those previously filled in or destroyed or are being eroded.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<i>Spartina alterniflora</i>	Seedlings (potted)	MTL - MHW MHW to + 1/4'	July 1974
B	<i>Spartina alterniflora</i>	Seedlings (bare root)	MTL - MHW MHW to + 1/4'	May, June 1975
C				
D				
E				
F				
G				
H				
I				

- (c) Endemic plant stock was ☐ was not ☒ used. If "was not used," indicate geographic origins of various stock used.
Seed from New Jersey and Long Island was used to grow the seedlings planted.
- (d) If plant stocks were purchased, what were the sources?

Environmental Concern

- (e) What mechanisms were employed for planting?
bulb planter
planting bar
pointed spade

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A			
B			
C			
D			
E			
F			
G			
H			
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	Approximately 70% survival of peat potted seedlings planted in 1974.
B	Seedling survival and growth currently being evaluated; 1/4 acre of seedlings planted in mid-April did not survive. Temperature shock and small size of seedlings believed to have been limiting factors.
C	
D	
E	
F	
G	
H	
I	

please list references to available published material (on project) not given in Table 3.

Tidal Marsh Restoration at Hempstead, Long Island, by Orville W. Terry, Harold F. Udell, and John Zarudsky. This article, however, cites experimental work done on adjacent pipeline where more muddy sediments were encountered.

ARTICLE TO APPEAR
IN SHORE AND
BEACH MAGAZINE

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?
1. Planting of young bare root seedlings too early (before May) in season (morning temperatures in 40°) might be unproductive.
 2. Some peat potted seedlings were subject to wind and boat generated waves
 3. Some eating of stems by waterfowl in spring. causing displacement of sediments from around roots.
- (c) The problems listed in 9(b) have ☒ have not ☐ been resolved. If the problems have been resolved, please describe the solutions.

Delay time of planting until May unless using well developed stock. Some erosion expected; if it increases or becomes severe, a low berm should be constructed on the wind generated side.

- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☒ do not ☐ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?

Browsing of new shoots by Brant in the spring months. Observed for the first time this year (1975). Damage not severe. Browsing expected to have a pruning effect on plants. We will continue to observe effects.

- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?

- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

During the leveling and grading of the site by bulldozer, I would recommend leaving at least a low ridge or berm one foot high on the side facing open water which receives the effects of wind generated waves. Water circulation and penetration of the site would occur via the accessory canals and laterally from the non-dominant wind and/or boat generated wave side.

1976 - Work on North Line Island

Approximately two acres of tidal area were planted on 2-ft centers with nursery stock of S. alterniflora in May and June, 1976. Plant development was poor and was not markedly improved through fertilization except along the seaward edges of the disposal area. It is expected that high salinities of the intertidal water is limiting plant development in the interior areas of the site.

Canada geese damage of the planted areas was particularly severe during September - October 1976.

AD-A041 464

ENVIRONMENTAL CONCERN INC ST MICHAELS MD
RECENT AND PLANNED MARSH ESTABLISHMENT WORK THROUGHOUT THE CONT--ETC(U)
APR 77 E W GARBISCH

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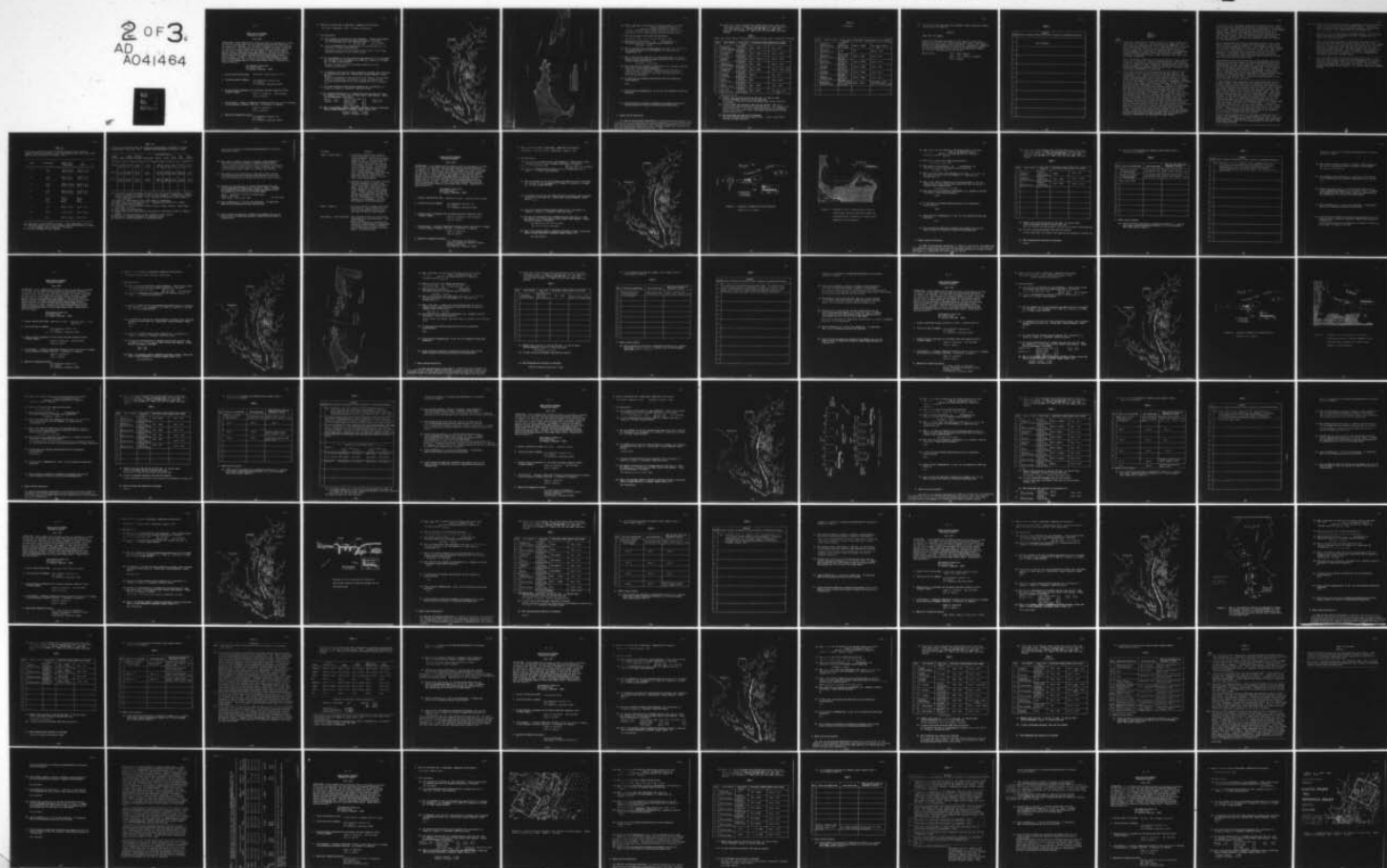
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NL

2 OF 3
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A041464



No. 5

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Hambleton Island (quarry fill)
2. Institution and its address: Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663
3. Persons directly responsible for the project and their respective office telephone numbers:
Edgar W. Garbisch 301-745-9620
Paul B. Woller
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
Edgar W. Garbisch
Paul B. Woller
5. Agency(ies) funding the project: Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663

6. Dates of initiation and, if applicable, completion of the project:

Initiated: September, 1971; Project continuing.

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

U.S. C & GS Chart No. 550 76° 14' Long See attached
38° 45' Lat

- (b) Is site a dredged material disposal area ☐, a natural area ☐, or other ☒? If other, please describe.

Intertidal sand flat constructed in the winter, 1971 using sediment obtained from an inland quarry.

- (c) Are the sediments at the site unconfined and unprotected ☐ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☒? If other, please describe.

Portion of area initially provided protection using temporary breakwaters.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

Temporary breakwaters constructed of PVC tubing, polyethylene sheets, and wood were installed at start of project and provided some protection to most exposed portion of project site.

- (e) Are areas involved in marsh creation regularly ☒, occasionally ☐, seldom ☐, always ☐, inundated? Check one or more.

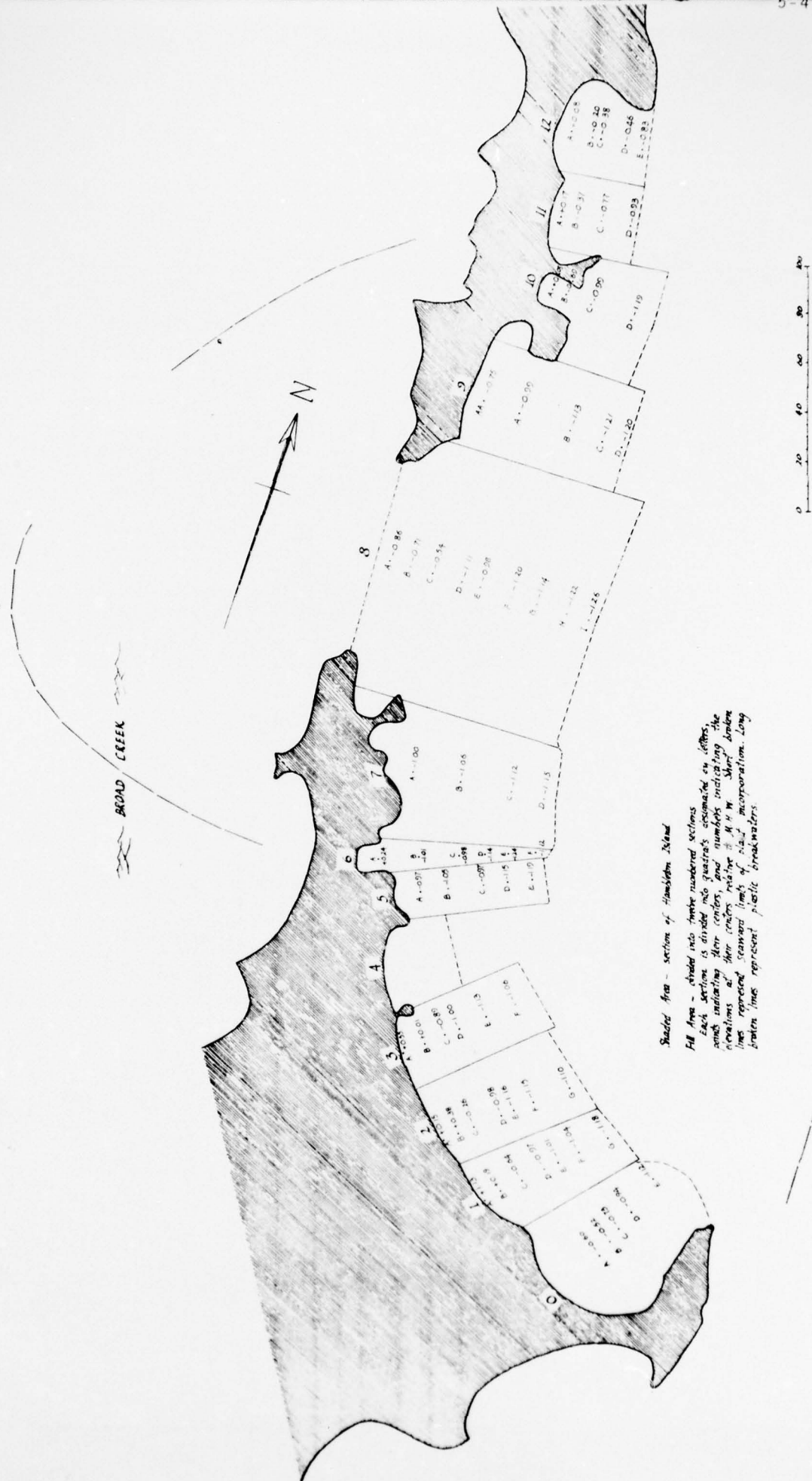
- (f) Are physical characteristics of sediment mud (silt and clay) ☒, sand ☒, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

Pebble: 2.0	Very coarse sand: 0.1	Silt: 9.7
Granule: 2.4	Coarse sand: 5.5	Clay: 6.5
	Medium sand: 34.8	
	Fine sand: 30.4	
	Very fine sand: 8.7	

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

Organic carbon: 0.059%
Organic nitrogen: 0.011%





Shaded area - section of Hamilton Island

Full area - divided into twelve numbered sections. Each section is divided into quadrats designated by letters, and numbers indicating their centers, and numbers indicating the elevations at their centers relative to M.H.W. Short broken lines represent seaward limits of tidal incorporation. Long broken lines represent plastic breakwaters.

SAN DOMINGO CREEK

- (h) What is the range (in degrees) of the surface slopes at the site?
 10° - 50° What is the dominant slope? 20°
 How were the slopes achieved (e.g. natural or bulldozer grading)? Slope created during placement of fill material at site; some natural grading also occurred.
- (i) What are the major fetch lengths and directions?
 2.2 mi (3.5 km) - SE; 2.0 mi (3.2 km) - NW
- (j) What wind directions prevail SW and dominate? NW
 During what months are the dominant winds encountered?
 November - March
- (k) What is the mean lunar tidal amplitude at the site? 1.4 ft (43 cm)
 Are wind influences on the tide dominant / /, significant / /, insignificant / /?
- (l) What is the chemical composition of the receiving water at the site (annual salinity range and any known constituents that are present in unusually high concentrations)?
 Salinity: 8-12 ‰
- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally.
 Tidal flat was created by placement of fill material in subtidal areas alongshore. Specifications regarding elevations and slopes of the tidal flat were met during the filling operation.
- (n) If there were any problems associated with the site preparation, please describe.
 None.
- (o) Please provide recommendations, if any, for site preparation based upon experience.
- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives? To (a) explore establishment of 13 species of salt and brackish water marsh vegetation from greenhouse cultivated plant stock transplanted at the site and (b) determine to what extent the established vegetation traps sediment eroded from adjacent sections of unprotected shore at the site. B46

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

NOTE: all plant stock of Maryland-Virginia origin unless otherwise indicate

CODE	PLANT SPECIES	PLANT STOCK (Age)	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Ammophila breviligulata</u>	potted seedlings (9 wks)	MHW - MHW + 1ft	May, 1972
B	<u>Distichlis spicata</u>	potted seedlings (10 wks)	MTL - MHW + 1ft	April, 1972
C	<u>Spartina patens</u>	potted seedlings (11 wks)	MTL - MHW + 1ft	April, 1972
D	<u>Spartina cynosuriodes</u>	potted seedlings (11 wks)	MTL - MHW	April, 1972
E	<u>Phragmites communis</u>	potted seedlings (12 wks)	MTL<- MHW	April, July, 1972
F	<u>Panicum virgatum</u>	potted seedlings (10 wks)	MHW ≤	May, 1972
G	<u>Typha latifolia</u>	potted seedlings (11 wks)	MTL	July, 1972
H	<u>Typha angustifolia</u>	potted seedlings (12 wks)	MTL - MHW	July, 1972
I	<u>Spartina alterniflora</u>	potted seedlings (8-15 wks)	MTL<-≤MHW	May thru July, 1972

continued on 4a

- (c) Endemic plant stock was \bar{X} was not \bar{X} used. If "was not used," indicate geographic origins of various stock used. Assateague, Virginia; middle Chesapeake Bay; North Carolina outer banks.
- (d) If plant stocks were purchased, what were the sources? Seed of *S. alterniflora* (North Carolina) provided by Dr. E.D. Seneca, N.C. State University. All other seed harvested by Environmental Concern Inc. and plant stock cultivated therefrom by Environmental Concern Inc.
- (e) What mechanisms were employed for planting? Seeding accomplished using roto-tiller. Plant stock incorporated by hand (shovel).

TABLE 1
continued

CODE	PLANT SPECIES	PLANT STOCK ELEVATIONS (Age)	PLANTED MONTH-YEAR	PLANTED
J	<u>Spartina alterniflora</u> (N. Carolina)	potted seedlings (8-15 wks)	MLW < , ≤ MHW	May thru August 1972
K	<u>Spartina alterniflora</u>	seed	MTL	April, 1973
L	<u>Spartina alterniflora</u>	bare root seedlings (10 wks)	MLW < , < MTL	June, 1973
M	<u>Scirpus americanus</u>	potted seedlings (12 wks)	MTL ≤ , < MHW	June, 1973
N	<u>Scirpus olneyi</u>	potted seedlings (12 wks)	MTL ≤ , < MHW	June, 1973
O	<u>Scirpus robustus</u>	bare root seedlings (10 wks)	MTL ≤ , < MHW	June, 1973
P	<u>Juncus roemerianus</u>	potted seedlings (20 wks)	MTL ≤ , < MHW	July, 1973
Q	<u>Spartina alterniflora</u>	dormant pot- ted seedlings (8-12 wks)	MLW < , ≤ MTL	November, 1973 thru February, 1974

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

Table 2

Code does not apply.

Fertilizer programs initiated in 1973 and all plant stock present at the site was fertilized at that time. Additional applications were made in 1974 and 1975. A mixture of ammonium nitrate and superphosphate (4.5 N/1P) was broadcast throughout the planted area at low tide on each application date, at a rate of 100 lb/N and 22 lb P/acre.

Applications:	1973 - July, August
	1974 - July, August, September
	1975 - August

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	SEE ATTACHED:
B	
C	
D	
E	
F	
G	
H	
I	

TABLE 3
RESULTS

CODE

- A - H First year fatalities of plant stock of all these species was generally less than 5%. The two species of Typha were the least able to withstand wave stress and thus suffered the highest percentage of fatalities (i.e., 85%). Grazing of the new shoots by the Blue crab also contributed significantly to loss of Typha spp. transplants. Fatalities of S. cynosuroides transplants were largely related to elevation with lower elevation transplants having a lower survival rate than those at higher elevations.

Total first-year productions (root & aerial) for these species are given in Table 3a. Certain species showed a marked sensitivity of production with respect to elevation with production being the lowest at lower elevations, while percent root values varied between the species, these values within a species were relatively independent of elevation.

- I - J First year survival of transplants was on the order of 98%, irrespective of elevations at which stock was planted, the development (i.e., age) of the stock, and the time of planting. Linear regressions were derived for several indices of plant growth and development (root, aerial, and total biomass, number of culms, and number of flowers/transplant - dependent variables) with total time under cultivation at the end of the first growing season (independent variable). Analysis of covariance was used to test for differences between growth of transplants derived from seed collected in North Carolina and Virginia. The results of these calculations showed that significant ($P > .05$) correlations of production (root, aerial, and total dry weights) and number of flowers with total time under cultivation were found to exist and that the growth of seedlings derived from seed from Virginia did not differ from that of plants originating from seed collected in North Carolina. Although correlation of number of culms with time under cultivation was highly significant ($P > .001$) for Virginia plants, that for North Carolina plants was not significant ($0.2 < P < 0.1$). Regression lines for this growth indicator were different ($P > .01$) with that for North Carolina stock having a lower slope. Virginia origin plant stock located in an area subject to wave stress had significantly lower aerial and root productions and significantly higher percent root value than did Virginia transplants not subjected to wave stress.

Predation of the introduced plant stock by wildlife was severe during the winter following planting as Canada geese excavated and consumed approximately 70% of the established S. alterniflora transplants. Muskrat feeding was largely restricted to S. cynosuroides and all the transplants of this species were removed. Recovery of the area during the 1973 growing season was, however, rapid. Most of the transplants had flowered during 1972 and the seed therefrom produced seedlings throughout the damaged area.

Aerial productions of Virginia and North Carolina plant stock during the 1973 growing season were determined in areas which had not been damaged by wildlife. Live standing crops of both plant stocks were greater in 1973 than in 1972 (Va: 400% greater in 1973; N.C.: 650% greater in 1973). Unlike first-year productions of the plant stocks which were not statistically different, second-year live standing crops were different ($P > .001$) with that for North Carolina stock being 76% greater than that for Virginia plant stock.

Indications of the rate of recovery of the damaged area were obtained through live standing crop determinations within the damaged area in 1973, 1974, and 1975. The 1973 samples were of seedlings derived from naturally deposited seed and gave a mean live standing crop of $49.9 \pm 9.0\text{g}/0.25\text{m}^2$. Live standing crops at the end of the 1974 and 1975 growing seasons were $286.6 \pm 126.2\text{g}/0.25\text{m}^2$ and $337.9 \pm 106\text{g}/0.25\text{m}^2$, respectively. The live standing crop value obtained in 1974 was significantly greater ($P > .05$) than that in 1973 but not statistically different from that of 1975. Fertilizer applications to this area were made in 1973 and 1974.

K In both seeded areas (protected and unprotected with respect to wave stress) seed germination was high and development of emergent seedlings was such that a relatively uniform stand of 1-3" high seedlings was present within two months after seeding. Subsequent growth in the exposed area was poor, however, and only a few seedlings were present two months later. Nutrient deficiencies, wave stress, and low elevation (MLW - MTL) were believed responsible for the poor establishment. Plant establishment in the sheltered area was statistically ($P < 0.001$) inferior to that of a comparably sheltered area at the site containing plants derived from naturally deposited seed in terms of aerial production (introduced seed: $23.4 \pm 4.0\text{g}/0.25\text{m}^2$; naturally deposited seed: $49.9 \pm 9.0\text{g}/0.25\text{m}^2$). Both areas contained statistically insignificant numbers of culms (introduced: $119.0 \pm 24.6\text{ culms}/0.25\text{m}^2$; natural: $133.0 \pm 14.7\text{ culms}/0.25\text{m}^2$). Additionally, the naturally seeded area contained $19.0 \pm 4.0\text{ inflorescences}/0.25\text{m}^2$ while none of the plants in the artificially seeded area had flowered.

L Survival was estimated to be on the order of 85% and transplants were reasonably well established by the end of the first growing season. Planting was on 1.5 ft centers and individual transplant sites were still distinguishable at the end of the first growing season.

- M - N While initial survival was good, transplants were poorly established by the end of the first growing season. Shading by trees lining the shore and vegetative spread by nearby plantings resulted in the crowding out of the Scirpus spp.
-
- O Only those species planted near the MHW elevation survived and their first-year establishment was poor, largely owing to shading by shoreline trees.
-
- P Even under optimum greenhouse conditions the growth rate of this species from seed was markedly slower than any other species studied. Survival of transplants at the site was very low with only those transplants near the MHW elevation being viable two months after planting. The slow growth rate coupled with crowding effects from the spread of nearby S. alterniflora transplants resulted in complete loss of all transplants by the end of the first growing season.
-
- Q Less than 10% of the transplants produced new growth in the spring of the following year and was independent of elevation and time of planting. This result was primarily attributed to having planted the transplants too deep as those which did produce new growth were planted 1 to 2 inches below the sediment surface.

TABLE 3a

First-year production data for eight species of salt tolerant aquatic vegetation planted at the site between April and July, 1972. Samples were harvested in October, 1972.

Code	Elevation ^a	Mean Total Production	% Root
A	2.3	116.5 \pm 6.5	30.4 \pm 1.4
	1.5	25.4 \pm 17.0	33.9 \pm 5.9
B	2.1	69.1 \pm 6.1	54.8 \pm 1.5
	0.8	39.0 \pm 8.6	53.5 \pm 3.1
C	2.0	146.9 \pm 54.5	49.6 \pm 3.5
	0.8	52.8 \pm 11.3	40.7 \pm 3.8
D	1.4	99.8 \pm 51.2	63.4 \pm 3.3
	0.7	43.3 \pm 14.0	56.9 \pm 3.1
E	1.5	251.5	59.8
	1.1	173.0	60.5
	1.0	49.8	58.5
F	1.6	60.8 \pm 27.6	46.0 \pm 3.6
G	0.6	37.4 \pm 15.2	74.1 \pm 10.1
H	0.9	102.4 \pm 30.8	77.9 \pm 2.7

- (a) Elevation in feet relative to MLW. Tidal amplitude is 1.4 ft.
 (b) Tabulated values are in g/transplant and are the means of three or more samples unless otherwise indicated.
 (c) Values are means of two samples.

TABLE 3b

First-year production data for *Spartina alterniflora* transplants planted between April and July, 1972. Samples were harvested in October, 1972.

Seed Source	Age ^b	Date Planted ^c	Growth Period ^d	Elevation ^e	Production ^f		% Root ^g	No. Culms	No. Flowers
					Aerial	Total			
Va-1 ^h	11.0 (0.4)	4-26-72 (1)	39.0 (0.4)	17.9 (1.5)	25.9 (22.2)	72.1 (36.4)	65.7 (7.8)	77.3 (7.6)	10.7 (1.7)
Va-2 ⁱ	11.3 (2.4)	6-14-72 (29)	32.9 (5.5)	11.5 (6.8)	64.6 (51.7)	143.2 (77.4)	56.3 (6.9)	108.8 (51.9)	9.8 (5.7)
N.C. ^j	12.2 (2.6)	6-8-72 (27)	35.2 (5.1)	10.4 (3.1)	69.5 (41.7)	148.7 (59.4)	53.3 (6.7)	73.2 (29.5)	11.2 (5.1)

- (a) Tabulated values are means of results for two or more plantings. Results of each planting is a means of six or more samples. Parenthetical values denote standard deviations. Each transplant contained a mean number of 7 ± 2 seedlings.
- (b) Length of time (weeks) stock cultivated in greenhouse.
- (c) Means date stock planted at site - Standard deviations are in days.
- (d) Total growth period (weeks)
- (e) Elevation (in cm relative to MLW) at which stock planted. Mean tidal amplitude is 43 cm.
- (f) Dry weight in g/transplant.
- (g) Means determined using arcsine transform of individual values of (%root) $\frac{1}{2}/100$.
- (h) Results of two plantings in area subject to wave stress.
- (i) Results of fifteen plantings in sheltered area.
- (j) Results of eight plantings in sheltered area.

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?
Plant nutrient availability greatly influenced vegetative establishment of most species. Minor problems were those associated with wave stress, elevation, and shading.
- (c) The problems listed in 9(b) have ☒ have not ☐ been resolved.
If the problems have been resolved, please describe the solutions.
Nutrient deficiencies corrected by fertilizer applications.
- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☒ do not ☐ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?
Major: Waterfowl, primarily Canada geese.
Minor: Muskrat
Very Minor: Blue crab, Deer
See attached
- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?
- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

ProblemAction

Major: Canada geese

1. Installed netting over seaward-most transplants at end of first growing season. Aerial plant parts were cut off, 1 inch mesh netting (metal or plastic) placed over plant sites, and netting anchored to substrate surface. Subsequent year's growth emerges through netting and root systems in mesh netting. Installation is permanent and lifetime dependent upon material used and rate of sedimentation. Mesh size smaller than 1 inch impairs plant development.
2. Approach to marsh from water restricted by placement of a barricade slightly (5-10ft) seaward of marsh edge. Barricade constructed of posts placed 8-12 feet apart with 1/16" diameter line strung between posts. Lines should be placed at elevations between MTL and MHW and may be separated by as much as 1 to 1.5 ft. Installation is either temporary or permanent, low cost, and requires little maintenance.

Minor: Muskrat

No action taken as damage inflicted not serious. May be advisable to control populations during first two years of marsh establishment.

Very Minor: Blue crab, Deer

Deer browsed foliage of high marsh vegetation but not extensively. No action taken.
Blue crab primarily a problem with regard to establishment of Typha spp. not widely used in marsh creation in salt and brackish water environments. No action taken.

No. 6

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Hambleton Island - Natural Shore (sand)
2. Institution and its address: Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663
3. Persons directly responsible for the project and their respective office telephone numbers:
Edgar W. Garbisch 301-745-9620
Paul B. Woller
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
Edgar W. Garbisch
Paul B. Woller
5. Agency(ies) funding the project:
U.S. Army, Corps of Engineers
Coastal Engineering Research Center
Kingsman Building
Fort Belvoir, Virginia 22060

6. Dates of initiation and, if applicable, completion of the project:

Initiated: February, 1973; Completed: August, 1974

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

U.S. C & GS Chart No. 550

76° 14' Long
38° 45' Lat see attached.

- (b) Is site a dredged material disposal area ☐, a natural area ☒, or other ☐? If other, please describe.

- (c) Are the sediments at the site unconfined and unprotected ☒ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins). N.A.

- (e) Are areas involved in marsh creation regularly ☒, occasionally ☐, seldom ☐, always ☐, inundated? Check one or more.

- (f) Are physical characteristics of sediment mud (silt and clay) ☐, sand ☒, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

87% Medium to very coarse sand

10% Fine to very fine sand

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

Not determined



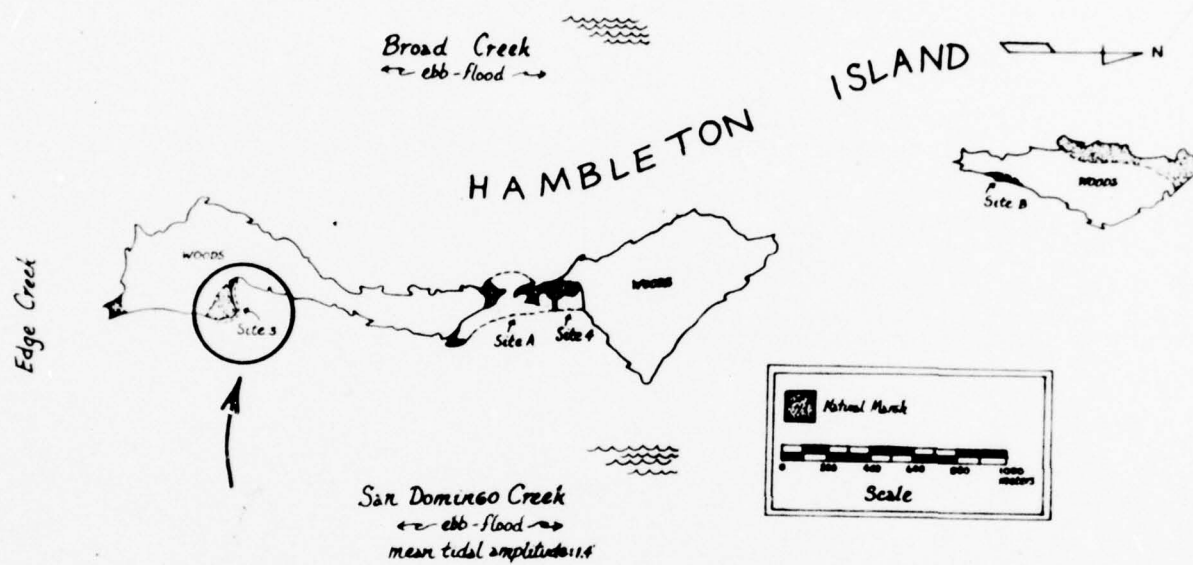


Figure 4. Drawing of Hambleton Island showing sites A, B, 3, and 4.

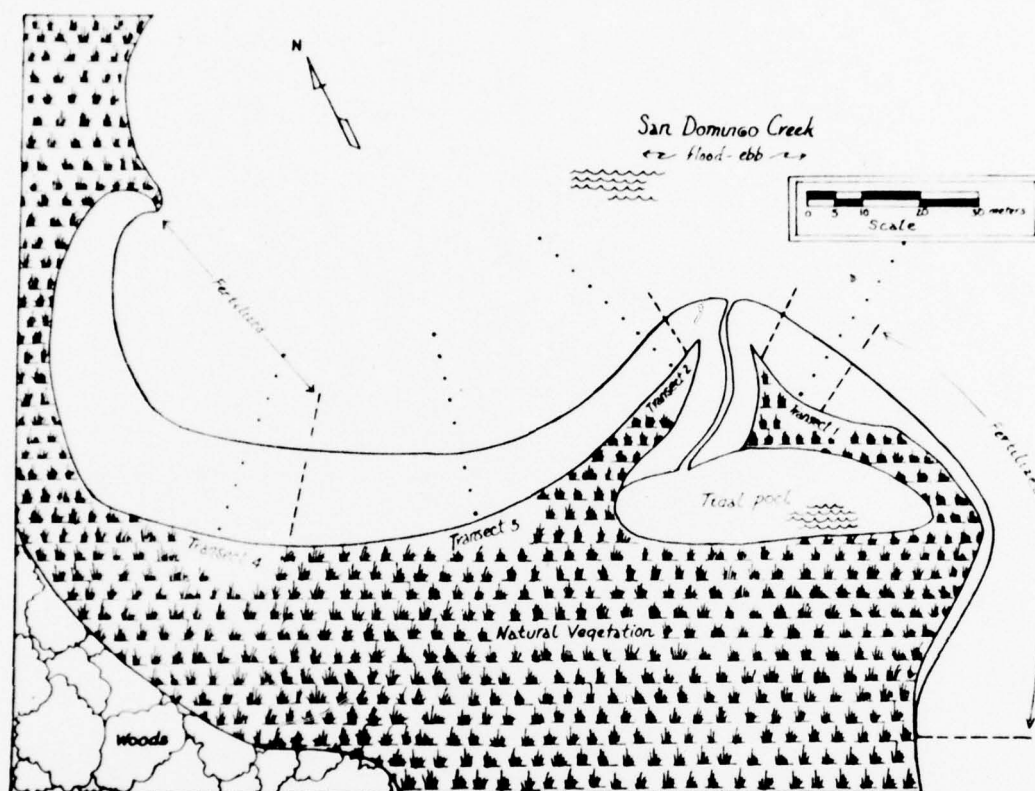


Figure 5. Drawing of site 3 showing the elevation monitoring transects passing through the planting areas in addition to those areas subject to fertilization.

- (h) What is the range (in degrees) of the surface slopes at the site?
 $3^{\circ} - 6^{\circ}$ What is the dominant slope? 5°
 How were the slopes achieved (e.g. natural or bulldozer grading)? Natural
- (i) What are the major fetch lengths and directions?
 0.7 mi (1.1 km) - NE
- (j) What wind directions prevail SW and dominate? NW
 During what months are the dominant winds encountered?
 November - March
- (k) What is the mean lunar tidal amplitude at the site? 1.4 ft (43 cm)
 Are wind influences on the tide dominant ☐, significant ☒, insignificant ☐?
- (l) What is the chemical composition of the receiving water at the site
 (annual salinity range and any known constituents that are present in unusually high concentrations)?
 Salinity: 8 - 12 0/00
- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally.
 None
- (n) If there were any problems associated with the site preparation, please describe.
 None
- (o) Please provide recommendations, if any, for site preparation based upon experience.
 N.A.
- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives? To identify limitations and potentials for vegetative stabilization of unprotected sandy shores and to determine the capability of established vegetation to increase elevations through sediment entrapment as a mechanism for shore erosion control.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK (Age)	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Spartina</u> <u>patens</u>	Potted seedlings (10-14 wks)	MHW <	May, 1973
B	<u>Spartina</u> <u>alterniflora</u>	Potted seedlings (10-14 wks)	MLW - MHW	April, 1973
C	<u>S.</u> <u>alterniflora</u>	Potted seedlings (10-14 wks)	MLW - MHW	April, 1973
D				
E				
F				
G				
H				
I				

- (c) Endemic plant stock was \bar{X} was not \bar{X} used. If "was not used," indicate geographic origins of various stock used.
Seed collected from Assateague, Virginia and Middle Chesapeake Bay
- (d) If plant stocks were purchased, what were the sources?
Potted seedlings cultivated from seed by Environmental Concern Inc.
- (e) What mechanisms were employed for planting?
Shovel

- (f) If fertilization programs were adopted, please complete Table 2
(code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A	Ammonium nitrate Superphosphate (4.5 N/1P)	37g mixture per transplant site	Surface application June, July, August, 1973
B	Ammonium nitrate Superphosphate (4.5 N/1P)	37g mixture per transplant site	Surface application June, July, August, 1973
C	Not fertilized		
D			
E			
F			
G			
H			
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	See: Garbisch, E.W. Jr., Woller, P.B., and McCallum, R.J., "Salt marsh establishment and development," Technical Memorandum No. 52, U.S. Army, Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Va., June, 1975.
B	
C	
D	
E	
F	
G	
H	
I	

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?

No problems encountered.

- (c) The problems listed in 9(b) have ☐ have not ☐ been resolved. If the problems have been resolved, please describe the solutions.

N.A.

- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☒ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?

- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?

- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

Fertilization generally recommended to optimize vegetative development in sandy substrates.

No. 7

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Hambleton Island - (Natural Shore - Silt and Clay)
2. Institution and its address:
Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663
3. Persons directly responsible for the project and their respective office telephone numbers:
Edgar W. Garbisch 301-745-9620
Paul B. Woller
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
Edgar W. Garbisch
Paul B. Woller
5. Agency(ies) funding the project:
Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663

6. Dates of initiation and, if applicable, completion of the project:

Initiated: March, 1972; Project continuing.

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

U.S. C&GS Chart No. 550 76° 14' Long See attached
38° 45' Lat

- (b) Is site a dredged material disposal area ☒, a natural area ☒, or other ☐? If other, please describe.

- (c) Are the sediments at the site unconfined and unprotected ☐ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

N.A.

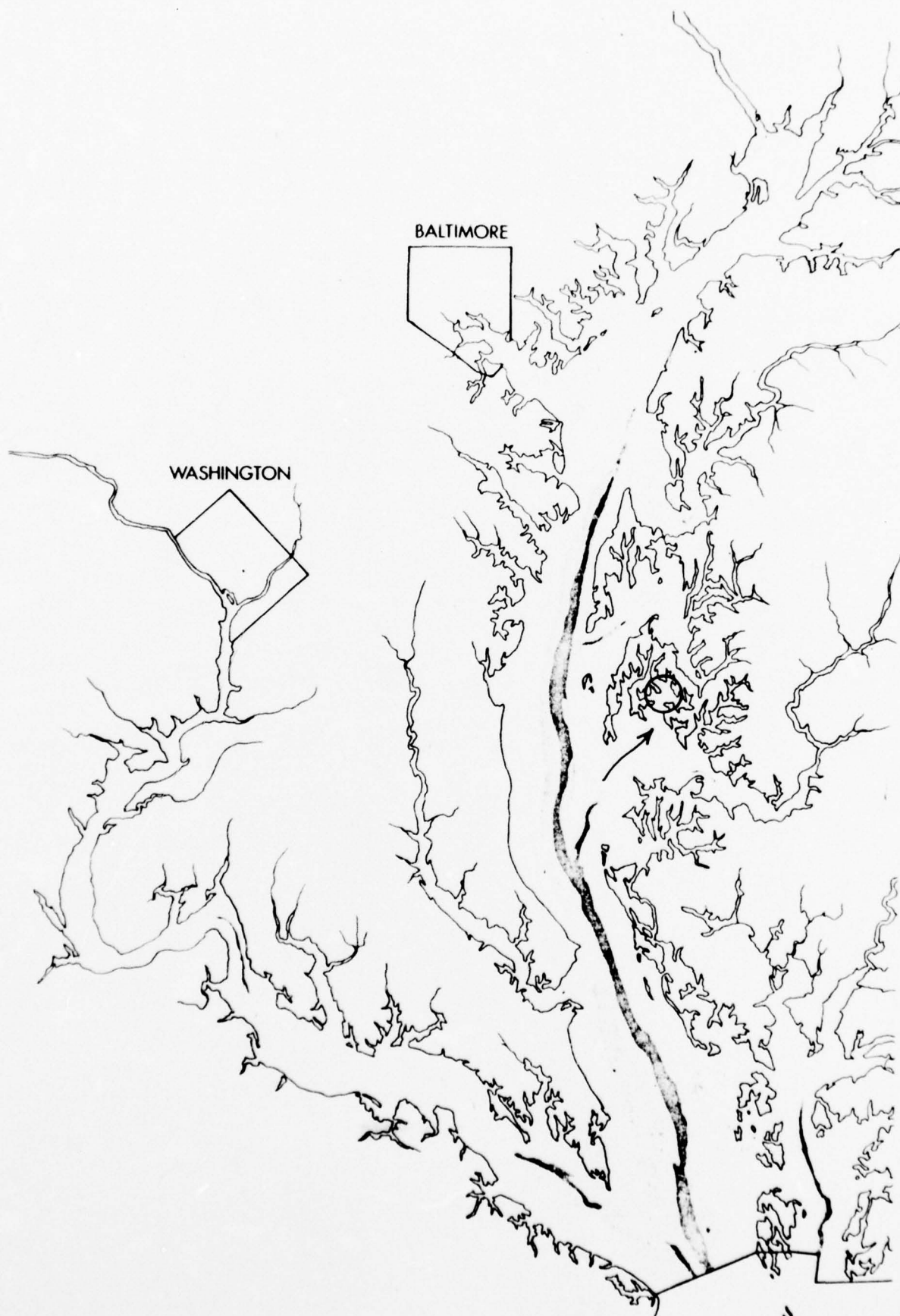
- (e) Are areas involved in marsh creation regularly ☒, occasionally ☐, seldom ☐, always ☐, inundated? Check one or more.

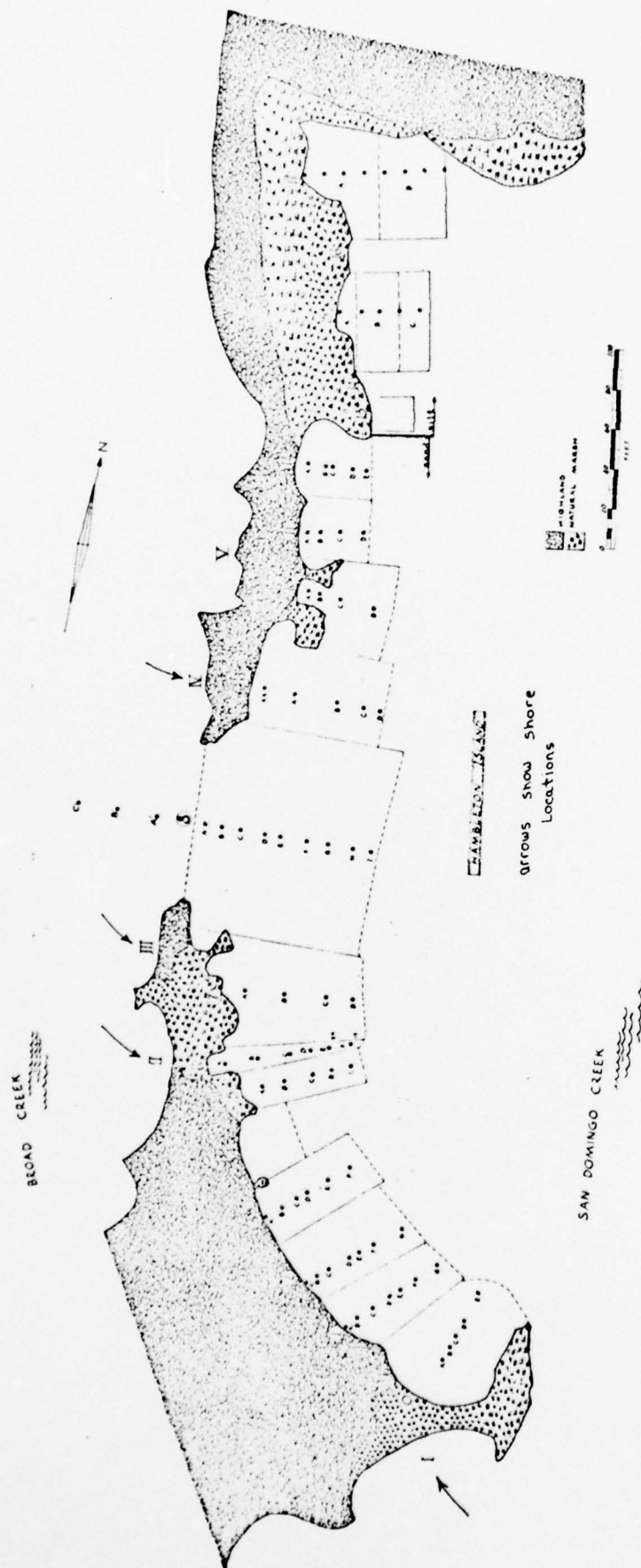
- (f) Are physical characteristics of sediment mud (silt and clay) ☐, sand ☐, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

Sand: 15%
Mud: 85%

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

Not determined





- (h) What is the range (in degrees) of the surface slopes at the site?

4 - 6°

What is the dominant slope? 5°

How were the slopes achieved (e.g. natural or bulldozer grading)? Natural

- (i) What are the major fetch lengths and directions?

2.2 mi (3.5 km) - SE; 0.25 mi (0.4 km) - E;

2.0 mi (3.2 km) - NW; 1.7 mi (2.8 km) - SW.

- (j) What wind directions prevail and dominate?

During what months are the dominant winds encountered?

November - March

- (k) What is the mean lunar tidal amplitude at the site? 1.4 ft (43 cm)

Are wind influences on the tide dominant ☐, significant ☒, insignificant ☐?

- (l) What is the chemical composition of the receiving water at the site (annual salinity range and any known constituents that are present in unusually high concentrations)?

Salinity: 8 - 12 0/00

- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally.

Fallen trees, driftwood, and other debris removed from planting site.

- (n) If there were any problems associated with the site preparation, please describe.

None

- (o) Please provide recommendations, if any, for site preparation based upon experience.

- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives? To investigate establishment of marsh vegetation on natural shore consisting of compact sediments having high percentages (>75%) of fine particles and the extent to which the established vegetation serves to trap and retain littoral drift and reduce soil erosion.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age) etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK (Age)	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Spartina alterniflora</u>	Peat potted seedlings (12-16 wks)	MLW - MHW	March, 1972, July, 1973, Dec.-Feb., 1974
B				
C				
D				
E				
F				
G				
H				
I				

- (c) Endemic plant stock was ☐ was not ☒ used. If "was not used," indicate geographic origins of various stock used.

Assateague, Virginia

- (d) If plant stocks were purchased, what were the sources?

- (e) What mechanisms were employed for planting?

Gasoline powered mechanical auger

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A	Ammonium nitrate Superphosphate (4.5 N/1P)	37g mixture per transplant site	Surface application June, July, August, 1973
B			
C			
D			
E			
F			
G			
H			
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	No standing crop determinations were made. It appears that annual fertilization is desirable in order to sustain a new marsh established in exposed and in high wave energy areas. Otherwise, only first year fertilizer may be necessary.
B	
C	
D	
E	
F	
G	
H	
I	

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?

An apparent annual decline in productivity was experienced in areas subject to high wave stress and which were never fertilized or fertilized only during the first year.

- (c) The problems listed in 9(b) have ☒ have not ☐ been resolved. If the problems have been resolved, please describe the solutions. Annual fertilizations sustain maximum productivity.

- (d) Wildlife have ☐ have not ☒ utilized created marsh areas and wildlife management problems do ☐ do not ☒ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?

Wildlife excavations of vegetation established in compact sediments have yet to be encountered.

- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?

- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

No. 8

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Hambleton Island - Dredged Material
2. Institution and its address: Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663
3. Persons directly responsible for the project and their respective office telephone numbers:
Edgar W. Garbisch 301-745-9620
Paul B. Woller
4. Interviewee(s) --- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
Edgar W. Garbisch
Paul B. Woller
5. Agency(ies) funding the project:
U.S. Army, Corps of Engineers
Coastal Engineering Research Center
Kingman Building
Fort Belvoir, Virginia 22060

6. Dates of initiation and, if applicable, completion of the project:

Initiated: February, 1973; Completed: August, 1974

Project monitoring on-going-

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

U.S. C & GS Chart No. 550 76° 14' Long See attached
38° 45' Lat

- (b) Is site a dredged material disposal area 38, a natural area 49, or other 1? If other, please describe.

- (c) Are the sediments at the site unconfined and unprotected ☐ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

N.A.

- (e) Are areas involved in marsh creation regularly \overline{X} /, occasionally \overline{J} /, seldom \overline{I} /, always \overline{I} /, inundated? Check one or more.

- (f) Are physical characteristics of sediment mud (silt and clay) \checkmark , sand \checkmark , pebbles \checkmark ? If more than one check, double check dominant. Please provide percentages if available.

Pebble: 0.0	Very coarse sand: 0.3	Silt: 35.4
	Coarse sand: 1.2	Clay: 6.5

Granule: 0.1	Medium sand:	3.4
	Fine sand:	17.2

Very fine sand: 36.0

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

Organic carbon: 0.42%

Organic nitrogen:0.05%



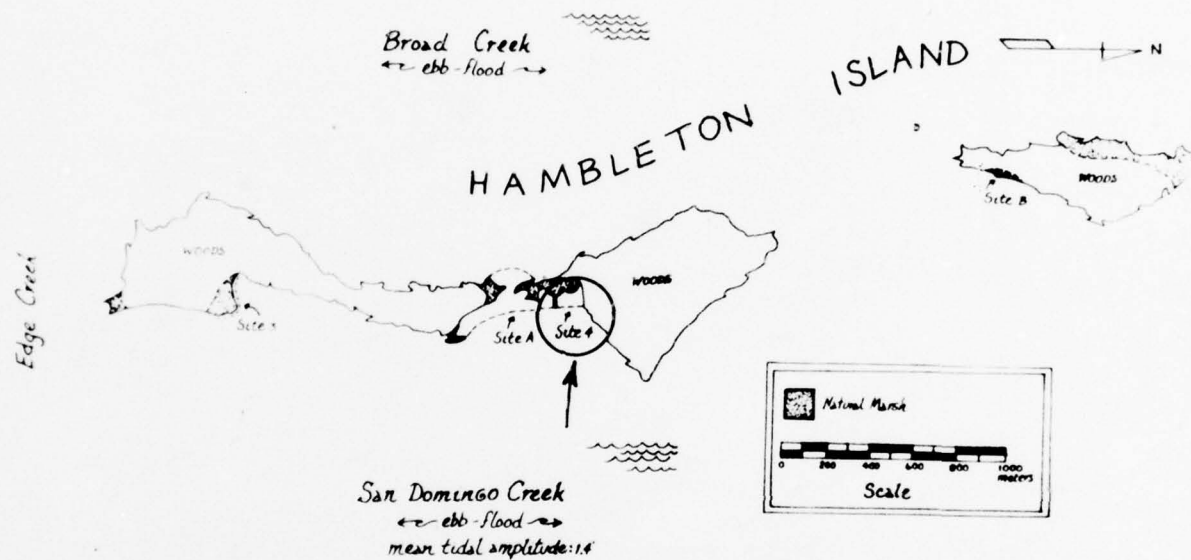


Figure 4. Drawing of Hambleton Island showing sites A, B, 3, and 4.

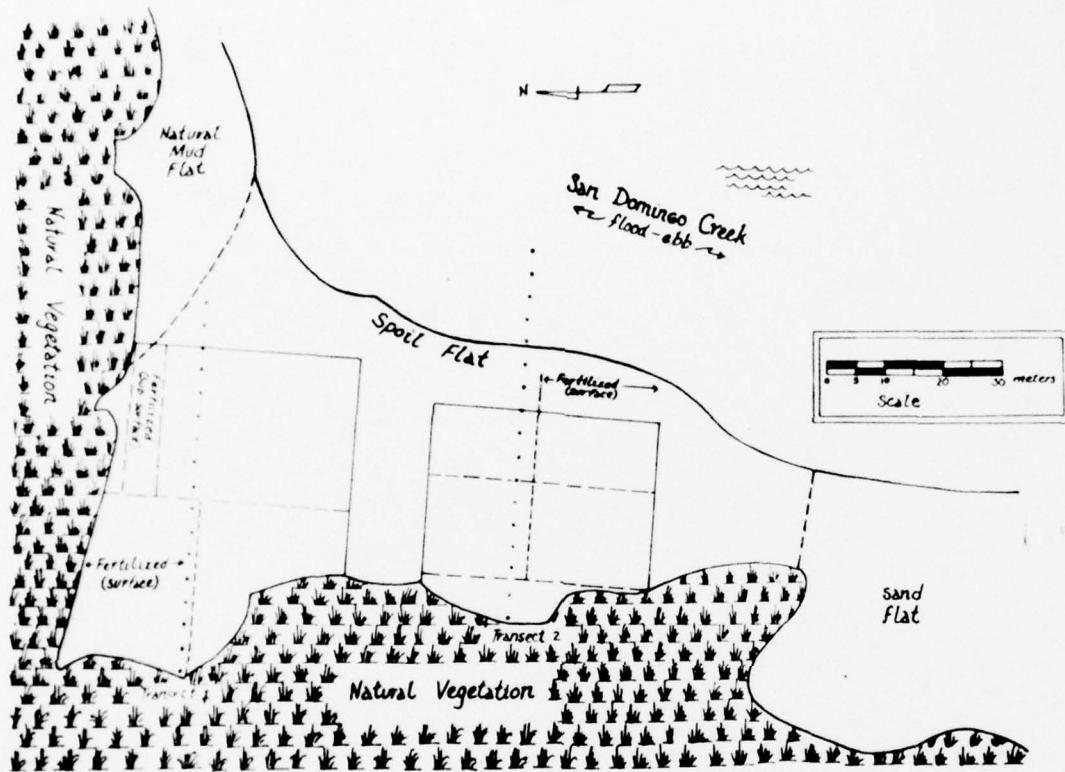


Figure 6. Drawing of site 4 showing the elevation monitoring transects passing through the two planting areas in addition to those areas subject to fertilization.

- (h) What is the range (in degrees) of the surface slopes at the site?
¹⁰ What is the dominant slope? ¹⁰
 How were the slopes achieved (e.g. natural or bulldozer grading)? Natural
- (i) What are the major fetch lengths and directions?
 2.2 mi (3.5 km) - SE
- (j) What wind directions prevail SW and dominate? NW
 During what months are the dominant winds encountered?
 November - March
- (k) What is the mean lunar tidal amplitude at the site? 1.4 ft (43 cm)
 Are wind influences on the tide dominant \bar{f} , significant \bar{K} , insignificant \bar{f} ?
- (l) What is the chemical composition of the receiving water at the site
 (annual salinity range and any known constituents that are present in unusually high concentrations)?
 Salinity: 8 - 12 0/00
- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally.
 Site preparation involved the conversion of a subtidal area to an intertidal one by the alongshore placement of dredged materials.
- (n) If there were any problems associated with the site preparation, please describe.
 Negligible.
- (o) Please provide recommendations, if any, for site preparation based upon experience.
- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives? To investigate the establishment of greenhouse cultivated seedlings of marsh vegetation transplanted in the tidal zone of a dredged material flat consisting of a high percentage of fine sediments.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK (Age)	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Spartina cynosuroides</u>	Potted seedlings (10-14 wks)	MTL <, <MHW	May, 1973
B	<u>Spartina alterniflora</u>	Potted seedlings (10-14 wks)	MTL - MHW	May, 1973
C	<u>S. alterniflora</u>	Potted seedlings (10-14 wks)	MTL - MHW	May, 1973
D	<u>S. alterniflora</u>	Potted seedlings (10-14 wks)	MLW - MTL	June, 1973
E	<u>S. alterniflora</u>	Potted seedlings (10-14 wks)	MLW - MTL	June, 1973
F	<u>S. alterniflora</u>	Potted seedlings (10-14 wks)	MLW - MTL	June, 1973
G				
H				
I				

- (c) Endemic plant stock was /X/ was not /X/ used. If "was not used," indicate geographic origins of various stock used.
Assateague, Virginia and Middle Chesapeake Bay
- (d) If plant stocks were purchased, what were the sources?
Potted seedlings cultivated from seed by Environmental Concern Inc.
- (e) What mechanisms were employed for planting?
Shovel

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A	Ammonium nitrate Superphosphate (4.5 N/1P)	37g mixture per transplant site	Surface application June, July, August, 1973
B	See A	See A	See A
C			
D	See A	See A	Surface application July, August, 1973
E	See A	See A	Subsurface application June, 1973
F			
G			
H			
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

	RESULTS																											
CODE	(Provide literature references in lieu of results if considered desirable)																											
	See: Garbisch, E.W., Jr., Woller, P.B., and McCallum, R.J., "Salt marsh establishment and development", Technical Memorandum No. 52, U.S. Army, Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Va., June, 1975.																											
	Spartina alterniflora above ground standing crop data for 1974 and 1975 is given below. By 1974, differences in the standing crops of transplants originally planted on 2 ft (0.6 m) and 3 ft (0.9 m) centers were not statistically significant and an overall 92% increase in live standing crop was noted between 1973 and 1974. At the end of the 1975 growing season, the live above-ground standing crop had decreased significantly (33%) but total standing crops at the end of the 1974 and 1975 growing season were comparable, suggesting that a significant amount of the 1974 production was not exported from the area by tides or through decay.																											
	<div>————— Aboveground Standing Crop^a —————</div> <table><tr><th rowspan="2">Spacing</th><th colspan="2">Live</th><th colspan="2">Total</th></tr><tr><th>1974</th><th>1975</th><th>1974</th><th>1975</th></tr><tr><td>2 ft (0.6 m)</td><td>410.2±58.4</td><td>277.7±67.3</td><td>449.2±61.4</td><td>446.1±43.9</td></tr><tr><td>3 ft (0.9 m)</td><td>397.1±86.8</td><td>225.7±45</td><td>436.3±85.1</td><td>339.2±96.8</td></tr><tr><td>Overall^b</td><td>403.6±70.9</td><td>251.7±58.6</td><td>442.7±71.1</td><td>392.7±89.2</td></tr></table>				Spacing	Live		Total		1974	1975	1974	1975	2 ft (0.6 m)	410.2±58.4	277.7±67.3	449.2±61.4	446.1±43.9	3 ft (0.9 m)	397.1±86.8	225.7±45	436.3±85.1	339.2±96.8	Overall ^b	403.6±70.9	251.7±58.6	442.7±71.1	392.7±89.2
Spacing	Live		Total																									
	1974	1975	1974	1975																								
2 ft (0.6 m)	410.2±58.4	277.7±67.3	449.2±61.4	446.1±43.9																								
3 ft (0.9 m)	397.1±86.8	225.7±45	436.3±85.1	339.2±96.8																								
Overall ^b	403.6±70.9	251.7±58.6	442.7±71.1	392.7±89.2																								

(a) Tabulated values are in g/0.25 m² and represent the means of six (1974) and three (1975) samples harvested at the MTL elevation in October of the indicated years.

(b) Means of data for two spacings.

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?
Subsurface application of the fast release fertilizer at time of planting in the low permeability substrate led to plant fatalities.
- (c) The problems listed in 9(b) have ☒ have not ☐ been resolved.
If the problems have been resolved, please describe the solutions.
Use of controlled release fertilizer reduces probability of transplant fatalities by keeping nutrient levels below those toxic to plants.
- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☒ do not ☐ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?
Underground plant parts excavated and consumed by waterfowl and muskrats. Protective measures involved (a) installation of netting on sediment surface after first growing season and by (b) installation of fence along seaward edge of marsh.
- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?
- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

No. 9

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Rich Neck - (natural shore)
2. Institution and its address:
Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663
3. Persons directly responsible for the project and their respective office telephone numbers:
Edgar W. Garbisch 301-745-9620
Paul B. Woller
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.

Edgar W. Garbisch
Paul B. Woller
5. Agency(ies) funding the project:

U.S Army Corps of Engineers
Coastal Engineering Research Center
Kingman Building
Fort Belvoir, Virginia 22060

6. Dates of initiation and, if applicable, completion of the project:

Initiated: February, 1973

Completed: August, 1974

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

U.S. C & GS Chart No. 1225 76° 16' Long See attached

- (b) Is site a dredged material disposal area ☒, a natural area ☒, or other ☐? If other, please describe.

- (c) Are the sediments at the site unconfined and unprotected ☒ or protected ☐, confined ☒, by a breakwater ☐, a dike ☐, a groin ☒, or other ☐? If other, please describe.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

Riprap groin

- (e) Are areas involved in marsh creation regularly ☒, occasionally ☐, seldom ☐, always ☐, inundated? Check one or more.

- (f) Are physical characteristics of sediment mud (silt and clay) ☐, sand ☒, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

92% medium to very coarse sand.

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

Not determined



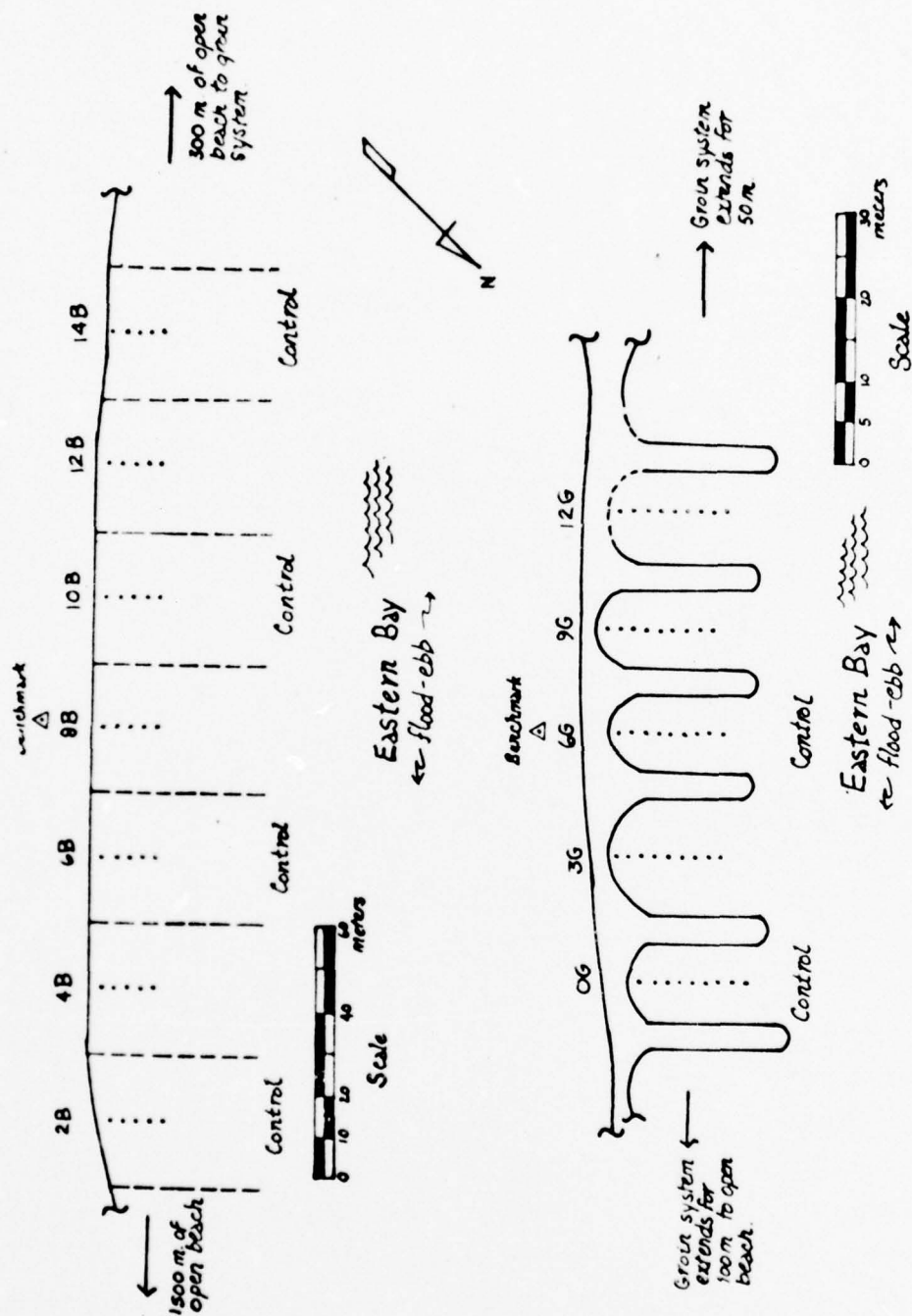


Figure 2. Site 1 showing profiles to monitor elevational changes and open beach and groin-planted control areas.

- (h) What is the range (in degrees) of the surface slopes at the site?
 4° - 6° What is the dominant slope? 5°
 How were the slopes achieved (e.g. natural or
 bulldozer grading)?
 Natural
- (i) What are the major fetch lengths and directions?
 5.4 mi (8.7 km) - N,NW; 16.7 mi (27 km) - S,SW
- (j) What wind directions prevail SW and dominate? NW
 During what months are the dominant winds encountered?
 November - March
- (k) What is the mean lunar tidal amplitude at the site? 1.2 ft (37 cm)
 Are wind influences on the tide dominant ☐, significant ☒,
 insignificant ☐?
- (l) What is the chemical composition of the receiving water at the site
 (annual salinity range and any known constituents that are present in
 unusually high concentrations)?
 Salinity: 8-12 0/00
- (m) Were there any site preparation requirements (e.g., grading to specific
 elevations)? Please specify generally.
 None
- (n) If there were any problems associated with the site preparation,
 please describe.
 None
- (o) Please provide recommendations, if any, for site preparation based upon
 experience.
 N.A.
- (p) Please provide any additional information and comments that you feel
 might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives? To identify limitations and potentials
 for vegetative stabilization of open and groin protected sandy shore and to
 determine the capability of established vegetation to increase elevations
 through sediment entrapment as a mechanism for shore erosion control.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Ammophila breviligulata</u>	potted seedlings (10-14 wks)	MHW+1 → MHW+2	May, 1973
B	<u>A. breviligulata</u>	potted seedlings (10-14 wks)	MHW+1 → MHW+2	May, 1973
C	<u>Distichlis spicata</u>	potted seedlings (10-14 wks)	MHW → MHW+2	May, 1973
D	<u>D. spicata</u>	potted seedlings (10-14 wks)	MHW → MHW+1	May, 1973
E	<u>Spartina patens</u>	potted seedlings (10-14 wks)	MHW → MHW+1	May, 1973
F	<u>S. patens</u>	potted seedlings (10-14 wks)	MHW → MHW+1	May, 1973
G	<u>Spartina alterniflora</u>	potted seedlings (10-14 wks)	MTL> → MHW+1	May, 1973
H	<u>S. alterniflora</u>	potted seedlings (10-14 wks)	MTL> → MHW+1	May, 1973
I	<u>S. alterniflora</u>	potted seedlings (10-14 wks)	MHW ≤	June, 1973

J-K*

- (c) Endemic plant stock was ☐ was not ☒ used. If "was not used," indicate geographic origins of various stock used.

Assateague, Virginia - Middle Chesapeake Bay

- (d) If plant stocks were purchased, what were the sources?

Potted seedlings cultivated from seed by Environmental Concern Inc.

- (e) What mechanisms were employed for planting? Shovel.

*J	<u>S. alterniflora</u>	potted seedlings (10-14 wks)	MHW ≤	June, 1973
*K	<u>S. alterniflora</u>	potted seedlings (10-14 wks)	MHW ≤	June, 1973

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A	Ammonium nitrate Superphosphate (4.5N/1P)	37g of mixture per transplant site	Surface application June, July, August, 1973
B			
C	See A	See A	See A
D			
E	See A	See A	See A
F			
G	See A	See A	See A
H			
I	See A	See A	Surface application July, August, 1973
J	See A	See A	Surface application June, 1973

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	See: Garbisch, E.W., Jr., Woller, P.B., and Callum, R.J., "Salt marsh establishment and development", Technical Memorandum No. 52, U.S. Army, Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Virginia, June, 1975.
B	
C	
D	
E	
F	
G	
H	
I	

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?
Wave stress at site sufficiently intense that vegetation below MHW elevation could not be established.
- (c) The problems listed in 9(b) have ☐ have not ☒ been resolved. If the problems have been resolved, please describe the solutions.
Establishment of vegetation below MHW elevation not pursued further at this site.
- (d) Wildlife have ☐ have not ☒ utilized created marsh areas and wildlife management problems do ☐ do not ☒ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?
- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?
- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

No. 10

MARSH CREATION RESEARCH
INFORMATION REQUEST

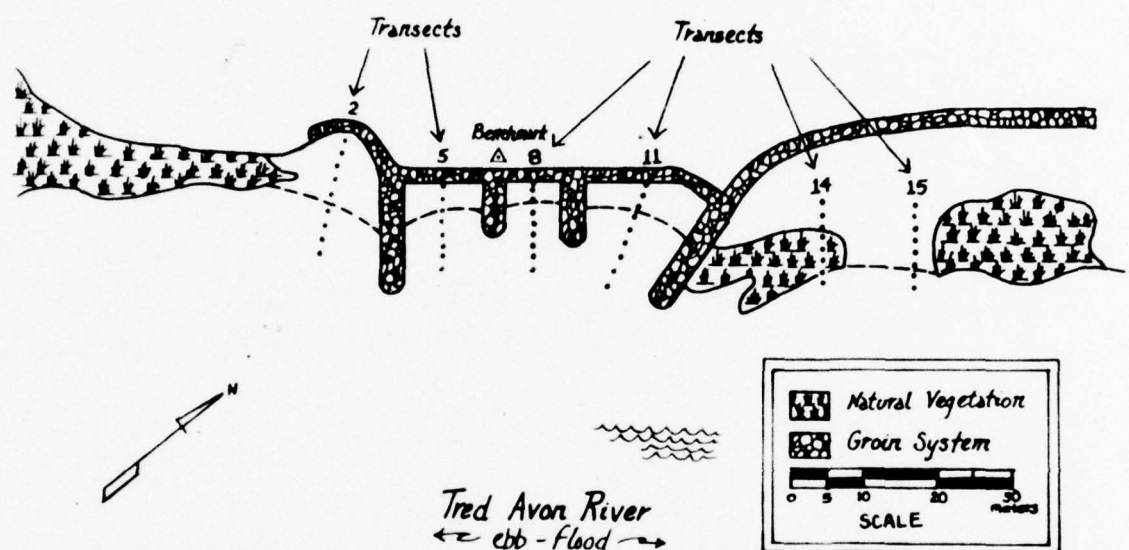
April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Tred Avon River (natural shore)
2. Institution and its address: Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663
3. Persons directly responsible for the project and their respective office telephone numbers:
Edgar W. Garbisch 301-745-9620
Paul B. Woller
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
Edgar W. Garbisch
Paul B. Woller
5. Agency(ies) funding the project:
U.S. Army, Corps of Engineers
Coastal Engineering Research Center
Kingman Building
Fort Belvoir, Virginia 22060





Drawing of site 2 showing the elevation
monitoring transects passing through the six
planting areas.

- (h) What is the range (in degrees) of the surface slopes at the site?
 2° - 6° What is the dominant slope? 4°
 How were the slopes achieved (e.g. natural or bulldozer grading)? Natural
- (i) What are the major fetch lengths and directions?
 7.4 mi (12.0 km) - SE; 2.2 mi (3.5 km) - NE
- (j) What wind directions prevail SW and dominate? NW
 During what months are the dominant winds encountered?
 November - March
- (k) What is the mean lunar tidal amplitude at the site? 1.4 ft (43 cm)
 Are wind influences on the tide dominant \bar{J} , significant \bar{X} , insignificant \bar{J} ?
- (l) What is the chemical composition of the receiving water at the site
 (annual salinity range and any known constituents that are present in unusually high concentrations)?
 Salinity: 8 - 12 0/00
- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally.
 None
- (n) If there were any problems associated with the site preparation, please describe.
 N.A.
- (o) Please provide recommendations, if any, for site preparation based upon experience.
 N.A.
- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives? To identify limitations and potentials for vegetative stabilization of open and groin protected sandy shores and to determine the capability of established vegetation to increase elevations through sediment entrapment as a mechanism for soil erosion control.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK (Age)	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Ammophila breviligulata</u>	potted seedlings (10-14 wks)	MHW+1	May, 1973
B	<u>A. breviligulata</u>	potted seedlings (10-14 wks)	MHW+1	May, 1973
C	<u>Distichlis spicata</u>	potted seedlings (10-14 wks)	MHW → MHW+1	May, 1973
D	<u>D. spicata</u>	potted seedlings (10-14 wks)	MHW → MHW+1	May, 1973
E	<u>Spartina patens</u>	potted seedlings (10-14 wks)	MHW → MHW+1	May, 1973
F	<u>S. patens</u>	potted seedlings (10-14 wks)	MHW → MHW+1	May, 1973
G	<u>Spartina alterniflora</u>	potted seedlings (10-14 wks)	>MLW , < MHW	May, 1973
H	<u>S. alterniflora</u>	potted seedlings (10-14 wks)	>MLW , < MHW	May, 1973
I	<u>S. alterniflora</u>	potted seedlings (10-14 wks)	>MTL	June, 1973
J	<u>S. alterniflora</u>	potted seedlings (10-14 wks)	>MTL	June, 1973

- (c) Endemic plant stock was ☒ was not ☒ used. If "was not used," indicate geographic origins of various stock used.

Assateague, Virginia; Middle Chesapeake Bay

- (d) If plant stocks were purchased, what were the sources?

Potted seedlings cultivated from seed by Environmental Concern Inc., P.O. Box P, St. Michaels, Maryland 21663

- (e) What mechanisms were employed for planting?

Shovel

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A	Ammonium nitrate Superphosphate (4.5 N/1P)	37g mixture per transplant site	Surface application June, July, August, 1973
B			
C	See A	See A	See A
D			
E	See A	See A	See A
F			
G	See A	See A	See A
H			
I	See A	See A	Surface application July, August, 1973

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	See: Garbisch, E.W. Jr., Woller, P.B., and McCallum, R.J., "Salt marsh establishment and development", Technical Memorandum No. 52, U.S.Army, Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Virginia, June, 1975.
B	
C	
D	
E	
F	
G	
H	
I	

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?
Wave stress and abrasion of aerial plant parts resulting from wave movement of gravel sized particles limited plant establishment.
- (c) The problems listed in 9(b) have ☐ have not ☐ been resolved. If the problems have been resolved, please describe the solutions.
Transplanting nursery stock during most active part of growing season (June & July) minimizes loss due to sediment abrasion.
- (d) Wildlife have ☐ have not ☒ utilized created marsh areas and wildlife management problems do ☐ do not ☒ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?
- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?
- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

No. 11

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Long Point Island (natural shore)
(sand, silt, and clay)
2. Institution and its address: Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663
3. Persons directly responsible for the project and their respective office telephone numbers:
Edgar W. Garbisch 301-745-9620
Paul B. Woller
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.

Edgar W. Garbisch
Paul B. Woller
5. Agency(ies) funding the project:

James Rouse, owner of Long Point Island



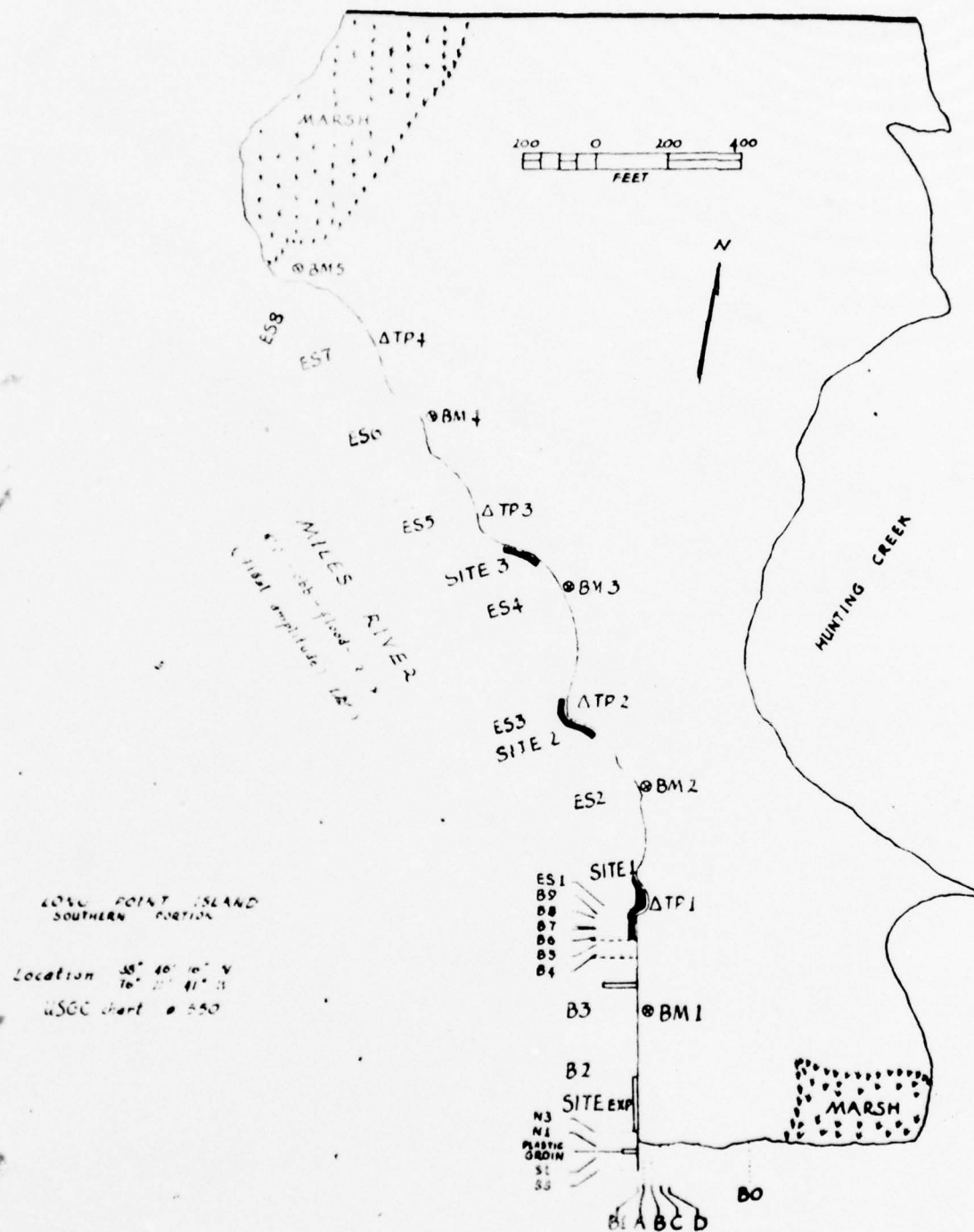


Figure 1. Map of the Southern portion of Long Point Island showing the location of benchmarks (BM), turning points (TP), profile leveling and shoreline erosion monitoring stations, plastic groin experiment, and planting sites.

- (h) What is the range (in degrees) of the surface slopes at the site?
 2° - 6° What is the dominant slope? 5°
 How were the slopes achieved (e.g. natural or bulldozer grading)? Natural slope
- (i) What are the major fetch lengths and directions?
 2.7 mi (4.4 km) NW; 1.5 mi (2.4 km) S, SW
- (j) What wind directions prevail SW and dominate? NW
 During what months are the dominant winds encountered?
 November - March
- (k) What is the mean lunar tidal amplitude at the site?
 Are wind influences on the tide dominant \checkmark , significant \bar{X} , insignificant \square ? 1.2 ft (37 cm)
- (l) What is the chemical composition of the receiving water at the site
 (annual salinity range and any known constituents that are present in unusually high concentrations)?
 Salinity 8 - 12 0/00
- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally.
 No
- (n) If there were any problems associated with the site preparation, please describe.
 N.A.
- (o) Please provide recommendations, if any, for site preparation based upon experience.
 N.A.
- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives? To determine the feasibility of establishing *Spartina alterniflora* (a) along a natural shore subject to seasonal wave stress and the extent to which the vegetation (1) traps littoral drift and (2) reduces shore erosion; (b) along the foot of a bulkhead to stabilize existing sediments. B109

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK (Age)	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Spartina alterniflora</u>	potted seedlings (3 mos)	MLW - MHW+1 (natural shore)	May, 1973
B	<u>S. alterniflora</u>	potted seedlings (3 mos)	MLW - MHW+1 (natural shore)	May, 1973
C	<u>S. alterniflora</u>	potted seedlings (3 mos)	MLW - MTL (bulkhead)	May, 1973
D	<u>S. alterniflora</u>	potted seedlings (3 mos)	MLW - MHW (natural shore)	July, 1973
E				
F				
G				
H				
I				

- (c) Endemic plant stock was ☐ was not ☒ used. If "was not used," indicate geographic origins of various stock used.

Assateague, Virginia

- (d) If plant stocks were purchased, what were the sources?

- (e) What mechanisms were employed for planting?

Shovel and gasoline powered auger.

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A	Ammonium nitrate Superphosphate (4.5 1N/P)	37 g mixture/ plant site	Surface application June, July, August, 1973 July, 1974
B			Surface application July, 1974 only
C	Same as A	Same as A	Surface application June, July, August, 1973
D	Same as A	Same as A	Surface application August, 1973; July, 1974
E			
F			
G			
H			
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

RESULTS

Code (Provide literature references in lieu of results if considered desirable)

- A-B First-year survival of transplants along the natural shore was greater than 80% with majority of losses occurring at the lower elevations. Loss of transplants resulting from washout was 10%. Total production for the first growing season was found to be markedly influenced by both elevation and fertilization (see Table 4). Total production of fertilized transplants at each elevation was generally twice that of unfertilized transplants at corresponding elevations. Irrespective of fertilizer treatment, total production at the MHW elevation was generally the greatest with differences between MHW +1ft and MTL generally not significant. Effects of fertilization and elevation on total production were indicated to be independent. Differences in percent root were significant only for fertilizer treatment with unfertilized transplants having greater root percentages. Plant establishment of fertilized transplants by the end of the first growing season was judged excellent although individual transplant sites were still visually detectable. Littoral drift accumulation within certain planted areas ranged between 0.1 and 0.5 ft. Winter survival of the plantings was excellent for fertilizer treated areas but on the order of 20% for unfertilized areas. Second-year growth resulted in uniform coverage of fertilized areas. Additional fertilizer applications did not assist previously unfertilized areas to recover from the winter damage and become established. These unfertilized areas were void of vegetative cover at the end of the second growing season.
- C Survival of transplants along the bulkhead during the first six months on the order of 25 - 30%. Less than 50% of the transplants were lost as a result of wash-out. Wave stress, particularly that arising from backwash of waves breaking on the bulkhead, was responsible for the high losses in this area. Fertilization had no visible effect on plant establishment. Within 9 months after planting there were no surviving transplants.
- D First-year survival was on the order of 50% with 25% of the transplants being lost as a result of wash-out. Fertilization produced visually detectable increases in plant pigment and aerial production relative to untreated transplants. By the end of the second growing season, surviving transplants had become well-established although the coverage of the area initially planted was non-uniform as a result of early transplant losses. Overall plant development was judged to be inferior to that of the other plantings and is ascribed to shading of the area by shoreline trees.

TABLE 4

11-9

Data pertaining to the first-year production of *Spartina alterniflora* planted at Long Point Island in May, 1973. Samples were harvested in October, 1973. Statistical analysis performed using analysis of variance^a.

Code	Total Production ^b	%Root	No. Culms	Mean Culm Height (cm)	No. Flowers
(MHW+1)	140.8 ± 24.7	46.1 ± 3.8	32.7 ± 9.8	50.5 ± 9.6	5.0 ± 3.0
(MHW)	232.5 ± 45.6	37.9 ± 8.8	44.3 ± 12.4	79.7 ± 14.3	13.7 ± 5.1
(MTL)	189.9 ± 29.6	43.4 ± 5.4	112.7 ± 29.0	41.7 ± 9.9	11.3 ± 3.0
Mean	187.7	42.5	63.2	57.3	10.0
(MHW+1)	62.9 ± 7.4	49.5 ± 18.6	22.3 ± 10.8	N.D. ^c	6.0 ± 2.0
(MHW)	120.3 ± 40.6	55.8 ± 4.8	40.1 ± 8.3	N.D. ^c	7.8 ± 3.3
(MTL)	36.5 ± 16.0	61.3 ± 7.3	43.0 ± 17.8	N.D. ^c	5.3 ± 4.2
Mean	73.2	55.5	35.1	N.D. ^c	6.4

Analysis of Variance (Total Production)

Source of Variation	F _s ^d	LSD ^e .05	81.2
		.01	113.8
		.001	160.8
Elevation (E)	10.458**		
Fertilization (F)	63.840***		
Interaction (E X F)	2.318 ^{ns}		

- . Tabulated values are means of three samples and are on a per plant basis.
. Dry weight (aerial & root) in g per plant site.
. Not determined.
. Statistical significance at probability levels indicated by: *≡ 0.95 ≤ P < 0.99; **≡ 0.99 ≤ P < 0.999; ***≡ P ≥ 0.999.
. Least significant differences.

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?

- (a) Shading along tree-lined portions of shore.
(b) Wave stress along bulkhead.

- (c) The problems listed in 9(b) have ☒ have not ☒ been resolved.
If the problems have been resolved, please describe the solutions.

Resolution of (a) would involve removal of shading branches of trees in order to provide direct sunlight for at least 30% of the photoperiod during the growing season. Resolution of (b) not pursued.

- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☒ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?

- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?

- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

It is recommended that for high energy sites such as this: (a) well-developed plant stock be planted as early in the spring as is feasible; (b) institute and continue appropriate fertilization programs as may be required. It has been found the alternate year fertilizations of planted areas subject to high wave stress during the growing season will be sufficient to sustain maximum plant productivity.

No. 12

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Susquehanna Delta
2. Institution and its address:
Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663
3. Persons directly responsible for the project and their respective office telephone numbers:
Edgar W. Garbisch 301-745-9620
Paul B. Woller
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
Edgar W. Garbisch
Paul B. Woller
5. Agency(ies) funding the project:
State of Maryland
Department of Natural Resources



- (h) What is the range (in degrees) of the surface slopes at the site?
 3 - 5° What is the dominant slope? 5°
 How were the slopes achieved (e.g. natural or bulldozer grading)? Natural slope
- (i) What are the major fetch lengths and directions?
 6 mi (9.6 km) S, SE; 3.7 mi (5.9 km) W, SW
- (j) What wind directions prevail SW and dominate? NW
 During what months are the dominant winds encountered?
 November - March
- (k) What is the mean lunar tidal amplitude at the site? 1.7 ft (52 cm)
 Are wind influences on the tide dominant /☐, significant /☒, insignificant /☐?
- (l) What is the chemical composition of the receiving water at the site (annual salinity range and any known constituents that are present in unusually high concentrations)?
 Mean Salinity: 0.7 0/00 3/73 thru 11/73
- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally.
 No
- (n) If there were any problems associated with the site preparation, please describe.
 N.A.
- (o) Please provide recommendations, if any, for site preparation based upon experience.
 N.A.
- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives? To explore the feasibility of vegetative establishment and substrate stabilization by seeding and planting dormant rhizome sections and various age seedlings of fresh-and salt-water emergent marsh vegetation.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age) etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK (Age)	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Typha angustifolia</u>	rhizomes	MLW - MTL	March, 1973
B	<u>Typha latifolia</u>	rhizomes	MLW - MTL	March, 1973
C	<u>Scirpus olneyi</u>	rhizomes	MLW - MTL	April, 1973
D	<u>S. olneyi</u>	potted seedlings (3 mos)	MLW - MTL	April, June, 1973
E	<u>S. olneyi</u>	potted seedlings (5 mos)	MLW - MTL	April, 1973
F	<u>S. olneyi</u>	bare root seedlings (3 mos)	MTW - MTL	April, 1973
G	<u>Scirpus americanus</u>	bare root seedlings (3 mos)	MTW - MTL	April, May, June 1973
H	<u>S. americanus</u>	potted seedlings (4 mos)	MLW - MTL	April, June, 1973
I	<u>S. americanus</u>	potted seedlings (6 mos)	MLW - MTL	June, 1973

(continued)

- (c) Endemic plant stock was ☒ was not ☐ used. If "was not used," indicate geographic origins of various stock used.
Middle Chesapeake Bay; Assateague, Virginia
- (d) If plant stocks were purchased, what were the sources?
Cultivated from seed by Environmental Concern Inc., P.O. Box P
St. Michaels, Maryland 21663
- (e) What mechanisms were employed for planting?
Bare root and small (2 1/2") peat-potted stock planted by hand and by mechanical transplanter. All other stock planted by hand.
Seeding accomplished using roto-tiller.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, agg), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1
Continued

CODE	PLANT SPECIES	PLANT STOCK (Age)	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
J	<u>Scirpus robustus</u>	bare root seedlings (3 mos)	MLW - MTL	April, May, June 1973
K	<u>S. robustus</u>	potted seedlings (4 mos)	MLW - MTL	April, 1973
L	<u>Spartina alterniflora</u>	seed	MLW - MTL	April, 1973
M	<u>S. alterniflora</u>	bare root seedlings (3 mos)	MLW - MTL	April, May, June 1973
N	<u>S. alterniflora</u>	potted seedlings (3 mos)	MLW - MTL	April, May, June 1973
O	<u>S. alterniflora</u>	potted seedlings (4 mos)	MLW - MTL	July, 1973
P	<u>Spartina cynosuroides</u>	seed	MLW - MTL	April, 1973
Q	<u>S. cynosuroides</u>	bare root seedlings (3 mos)	MTL	April, 1973
R	<u>Panicum virgatum</u>	seed	MLW - MTL	April, 1973

- (c) Endemic plant stock was ☐ was not ☐ used. If "was not used," indicate geographic origins of various stock used.

- (d) If plant stocks were purchased, what were the sources?

- (e) What mechanisms were employed for planting?

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
*	Ammonium nitrate Superphosphate	300 lb N/acre 66 lb P/acre	Surface application in August, 1973
N July	Urea	100 lb/acre	Surface application in July, 1973
0	Urea	30g/plant site	Subsurface application in July, 1973
0	Slow release (Scotts, 34-5-5)	30g/plant site	Subsurface application in July, 1973
N June	Ammonium nitrate Superphosphate (4.5N/1P)	37g mixture/plant site	Subsurface application in August, 1973
N June	Magnesium sulfate ($\text{MgSO}_4 \cdot 7 \text{H}_2\text{O}$)	3g/plant site	Subsurface application in August, 1973
N June	Calcium nitrate ($\text{Ca}(\text{NO}_3)_2 \cdot 4 \text{H}_2\text{O}$)	15g/plant site	Subsurface application in August, 1973
N June	Ammonium nitrate, Superphosphate, and magnesium sulfate	(45g mixture + 3g MgSO_4)/plant site	Subsurface application in August, 1973
N June	Ammonium nitrate, Superphosphate, and Calcium nitrate	(45g mixture + 15g $\text{Ca}(\text{NO}_3)_2$)/ plant site	Subsurface application in August, 1973

* All surviving plantings

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

ResultsCODE

- A-B Less than 20% of the transplants produced aboveground growth during the growing season. Clipping of emergent shoots by waterfowl inhibited later growth of survivors. No plants were in evidence by June.
-
- C-F Survival was on the order of 80% for oldest plant stock and decreased in the order E,D,F,C, with approximately 20% of C producing above-ground growth. Degree established (new shoots, coverage) was in the decreasing order given above. Wase stress and possibly low elevation adversely affected this species. Response to fertilization was not visually detectable.
-
- G-I Survival of all plant stock was approximately 80%. Establishment by G and H was comparable but inferior to that of I. Judged best of all Scirpus spp. planted to withstand wave stress. Response to fertilization was negligible. Establishment was greater at higher elevations than at lower elevations.
-
- J-K Survival of K greater than J. Wave stress resulted in loss of above-ground growth. Overall survival and eventual degree of establishment was lowest of all Scirpus spp. planted. Response to fertilization was not detectable. Low elevation at which planted may be partly responsible for poor growth.
-
- L Seed germination was high and seedlings were present within a month of seeding. Survival of emergent seedlings was low presumably owing to wave stress and sediment transport. Although the seeded area occupied some of the highest elevations at the site, the highest elevation was approximately MT. Thus, elevation also contributed to poor seeding survival and growth. Growth was considerably poorer than in seeded areas in higher salinity portions of the Chesapeake Bay. By July, less than 20% of the total seeded area contained vegetation deriving from seed. Seedlings exhibited no response to fertilizer treatment.
-
- M-O Survival of all transplants was on the order of 90% irrespective of the method of planting. Transplant establishment was superior to all species planted. Data pertaining to first year production of selected plantings is compiled in Table 4. Mean total production for O was statistically greater than M (May) and (June) but not different than N (May). N (May) total production was greater than productions of both N (June) and M (May) with the latter difference being greater than the former. Values for O/O root ranged between 45.2% and 56.3% and were not statistically different for the harvested plantings. Only N (May) set a significant number of flowers (6.7/plant site). Mean culm heights for N (May), N (June), and O were comparable (22.0 cm to 27.6 cm) and greater than that for M (May). Mean numbers of culms/plant site ranged from 67.7 to 95.7. Response to general and specific fertilizer treatments were largely visually undetectable. Only treatment of N (June) with ammonium nitrate-superphosphate with added calcium nitrate produced a detectable increase in pigmentation.
-

continued.

TABLE 3 continuedResults

- P Seed germination and survival of seedlings was low ($< 20\%$). Area seeded was void of seedlings approximately 1 month of emergence. Loss was attributed to inability of this species to survive at low elevations within the intertidal zone.
-
- Q Wave stress, waterfowl predation, and elevation (MLW - MTL) at which transplants could be planted contributed to loss ($> 90\%$) of plantings within 3 weeks after incorporation.
-

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?

See attached

- (c) The problems listed in 9(b) have ☒ have not ☐ been resolved. If the problems have been resolved, please describe the solutions.

See attached

- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☒ do not ☐ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?

See attached

- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?

- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

See attached

Poor vegetative establishment of species other than S. alterniflora and S. americanus was primarily attributed to wave stress and the absence of optimum elevations (i.e., MTL) at which to plant certain of the species. Wildlife predation of emerging foliage also hindered initial growth. Although these same factors reduced the degree of eventual establishment of S. alterniflora the effects were apparently less pronounced than in the other species. The lack of a response to fertilization was perhaps of greater consequence to S. alterniflora than were the aforementioned factors as fertilizer applications to transplants of this species in areas having comparable wave stress, elevations, and sediment compositions has resulted in a much higher level of establishment. These latter areas, however, had greater salinities (i.e., 10-15 ppt.) than the project site under discussion. The concentrations of sulfate and hardness (calcium and magnesium) in estuarine waters generally increase as the salinity increases. At brackish water sites (1- ppt salinity) the concentrations of sulfate and hardness were 10- to 100-fold greater than those at this site. It is tentatively felt that nutrient uptake by S. alterniflora is dependent upon the availability of sulfate and/or calcium and magnesium, either in the sediment or intertidal water.

Spartina alterniflora transplants planted at a different freshwater site, showed a marked response to treatment with a resin-coated, controlled release fertilizer applied at the time of planting. As analysis of the water at that site was not conducted, data regarding the concentration of sulfate and hardness is not available. At this same site, S. americanus was established using sprig and rhizome plant material. Establishment of S. cynosuroides was readily achieved at a brackish water site only at elevations greater than the MTL.

Predation by waterfowl presented the most serious problems. American brant were identified as being primarily responsible for clipping emergent shoots of the early (March-April) plantings. By November 1973, no less than 95% of the established vegetation had been excavated and consumed by migrating waterfowl, primarily Canada geese. Extensive wildlife management practices are needed at such sites,

Based on the results of the short-term study described above, the probability of successful marsh creation at this or a similar site could be increased by: (1) providing adequate protection to the plantings from wildlife predation; (2) using nursery stock (either bare root or potted) and plant as early in the spring as is feasible; (3) monitoring plantings closely for nutrient deficiencies and institute appropriate fertilization programs. With regard to (3) it may be advisable to attempt to determine beforehand the need or advisability of providing fertilizer treatment at the time of planting.

TABLE 4. Data pertaining to the first-year production of *Spartina alterniflora* planted at the Susquehanna Delta April thru July, 1973. Samples were harvested in October, 1973. Statistical analysis performed using analysis of variance.

CODE	Production (g/plant site) ^b			%	Number of		Mean culm
	Aerial	Root	Total		Culms	Flowers	
M (May)	9.7 ± 3.8	10.5 ± 2.7	20.2 ± 6.3	52.7 ± 6.5	67.7 ± 5.5	0.0	16.8 ± 2.4
N (May)	31.6 ± 13.0	24.9 ± 4.5	56.5 ± 17.2	45.2 ± 5.7	95.7 ± 16.8	6.7 ± 3.8	26.2 ± 0.5
N (June)	17.4 ± 10.1	16.0 ± 5.5	33.4 ± 15.4	49.6 ± 8.1	74.7 ± 17.2	1.7 ± 1.2	22.0 ± 1.6
ED	29.7 ± 3.1	38.1 ± 1.9	67.8 ± 3.7	56.3 ± 2.8	92.0 ± 9.8	2.0 ± 1.7	27.6 ± 2.9
F _S ^c	4.37*	28.3 ***	9.58**	1.79 ^{ns}	3.09 ^{ns}	5.26*	16.6***
LSD ^d	16.2	7.4	22.8			4.1	3.9
.05	23.5	10.8	33.1			5.9	5.7
.001	35.5	16.2	49.8			8.1	8.5

a. Tabulated values are means of three samples and are on a per plant site basis.

b. Dry weight.

c. Statistical significance at probability levels indicated by: * $\equiv 0.95 \leq P < 0.99$; ** $\equiv 0.99 \leq P < 0.999$; *** $\equiv P \geq 0.999$.

d. Least significant difference.

No. 13

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Sloop Channel (dredged material area)
2. Institution and its address: Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663
3. Persons directly responsible for the project and their respective office telephone numbers: Edgar W. Garbisch 301-745-9620
Paul B. Woller
4. Interviewee(s) — person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.

Edgar W. Garbisch
Paul B. Woller
5. Agency(ies) funding the project: Norfolk District Corps of Engineers
Fort Norfolk
803 Front Street
Norfolk, Virginia 23510

6. Dates of initiation and, if applicable, completion of the project:

Initiated: March, 1974

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

See attached

- (b) Is site a dredged material disposal area ☒, a natural area ☐, or other ☐? If other, please describe.

- (c) Are the sediments at the site unconfined and unprotected ☒ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

N.A.

- (e) Are areas involved in marsh creation regularly ☒, occasionally ☐, seldom ☐, always ☐, inundated? Check one or more.

- (f) Are physical characteristics of sediment mud (silt and clay) ☒, sand ☐, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

*Pebble: 0.1	*Very Coarse Sand: 0.1	Silt: 49.6
*Granule: 0.1	*Coarse Sand: 0.2	Clay: 22.3
	*Medium Sand: 0.4	
	Fine Sand: 2.5	
	Very Fine Sand: 24.7	

* particles consist of shell fragments.

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

Organic carbon: 0.75%
Organic nitrogen: 0.10%

- (h) What is the range (in degrees) of the surface slopes at the site?
 0.25° - 0.75° What is the dominant slope? 0.30°
 How were the slopes achieved (e.g. natural or bulldozer grading)? Natural
- (i) What are the major fetch lengths and directions?
 2 mi (3.7 km), West; 8 mi (14.8 km), South
- (j) What wind directions prevail southerly and dominate? northwesterly
 During what months are the dominant winds encountered?
 Winter
- (k) What is the mean lunar tidal amplitude at the site? 4.0'
 Are wind influences on the tide dominant \bar{X} , significant \bar{X} , insignificant \bar{X} ?
- (l) What is the chemical composition of the receiving water at the site (annual salinity range and any known constituents that are present in unusually high concentrations)?
 Salinity (0/00): January, 1974, 30.2; June, 1974, 29.9; September, 1974, 28.5.
- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally.
 None
- (n) If there were any problems associated with the site preparation, please describe.
 N.A.
- (o) Please provide recommendations, if any, for site preparation based upon experience. For unconfined dredge material having high percentage (> 70%) of mud (silt and clay), hydraulic dredge outfall should be placed as close to edge of fast land as is feasible and material should be pumped seaward. Optimum elevations for marsh establishment may be best achieved using retaining structures for sediments of this composition.
- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives? To explore mechanisms for effectively establishing Spartina alterniflora within intertidal dredged material areas consisting of unconsolidated mud sediments and subject to high physical stress.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age) etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK (Age)	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Spartina alterniflora</u>	seed	MTL → MHW	March, 1974
B	<u>S. alterniflora</u>	potted seedlings (20 wks)	MTL → MHW	June, 1974
C	<u>S. alterniflora</u>	potted seedlings (10 wks)	MTL → MHW	June, 1974
D	<u>S. alterniflora</u>	potted seedlings (4 wks)	MTL → MHW	June, 1974
E	<u>S. alterniflora</u>	bare root seedlings (10 wks)	MTL → MHW	June, 1974
F	<u>S. alterniflora</u>	mature, bare root	MTL → MHW	June, 1974
G	<u>S. alterniflora</u>	mature bare root	MTL → MHW	June, 1974
H	<u>S. alterniflora</u>	seed	- 1 ft, MHW	April, 1975
I	<u>S. alterniflora</u>	seed	- 1 ft, MHW	April, 1975

- (c) Endemic plant stock was ☒ was not ☐ used. If "was not used," indicate geographic origins of various stock used.

- (d) If plant stocks were purchased, what were the sources?

- (e) What mechanisms were employed for planting?

Seeding: All terrain vehicle & spike harrow, underwater furrower, underwater seeder, seed blower.

Planting: Shovel.

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A			
B			
C			
D			
E			
F			
G			
H	Scotts, 34-5-5 slow release Super Turf Builder	(a) 1,500 lb/acre (b) 3,000 lb/acre	side dressed at time of seeding
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

RESULTS

ODE (Provide literature reference in lieu of results if considered desirable)

A	Seed germination was high as early as six weeks after seeding (April 1974) a uniform stand of seedlings was observed in the area and by mid-May height of seedlings was on the order of 4-6 inches. Site inspection in mid-June, however, revealed the nearly total absence of all plant material.
B	Survival of transplants as of September, 1974 was 100% and aerial production was determined to be 55.4 ± 7.5 g/transplant, markedly lower than aerial production of comparable plant stock planted at a high mud content (60%) dredged material site in the Chesapeake Bay. The latter transplants were planted in May & June, 1974, harvested in October, 1974, and had a mean aerial production value of 315.0 ± 42.3 g/transplant.
C	Survival percentage for this plant stock was 60%. Aerial production by September, 1974, was determined to be 5.1 ± 2.2 g/transplant. In contrast, aerial production was found to be 117.3 ± 35.0 g/transplant for comparable plant stock planted in dredged material (60%) mud deposited in tidal waters in a tributary of the Chesapeake Bay. The latter transplants were planted in June, 1974 and harvested in October, 1974.
D	There were no surviving transplants by September, 1974.
E	There were no surviving transplants by September, 1974
F	Plant stock was planted as single culm units and there were no surviving transplants by September, 1974.
G	Plant stock was planted as four culms/site and survival was 46% as of September, 1974.
H	Did not verify extent of seed germination; however, by September, 1975 no plants were established within seeded areas.
I	Same as H

For more detailed information see:

Garbisch, E.W., Jr., Woller, P.B., and McCallum, R.J., "Salt Marsh Establishment on Intertidal Dredged Material Areas on the Coast of Virginia", Report submitted to Norfolk District Corps of Engineers Fort Norfolk, 803 Front Street, Norfolk, Virginia 23510. 1975.

please list references to available published material (on project) not given in Table 3.

(b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment? or establishment of introduced vegetation appears to have been the result of) nutrient deficiencies, (b) absence of optimum elevations at which to introduce nt stock, (c) high water turbidity, and (d) wave stress. Difficulties were so encountered regarding mechanisms for the introduction of plant stock (seed d/or live plant material).

(c) The problems listed in 9(b) have ☐ have not ☐ been resolved. If the problems have been resolved, please describe the solutions. rtilization upon seeding did not assist vegetative establishment by seeding, was hoped (see Code H in Tables).

(d) Wildlife have ☐ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☐ exist. If manage- ment problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?
Not determined

(e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?

(f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.
Marsh establishment on low fertility dredged materials that are subject to high wave stresses and are at marginal elevations should be accomplished with mature nursery plant stock. Other approaches are not likely to succeed. Recent results indicate that fertilization with Osmocote 19-6-12, 3- to 4-month release fertilizer (40 g/plant site) at the time of planting will markedly accelerate plant establishment.

No. 14

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Burton's Bay (dredged material)
2. Institution and its address:
Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663
3. Persons directly responsible for the project and their respective office telephone numbers:
Edgar W. Garbisch 301-745-9620
Paul B. Woller
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
Edgar W. Garbisch
Paul B. Woller
5. Agency(ies) funding the project:
Norfolk District Corps of Engineers
Fort Norfolk
803 Front Street
Norfolk, Virginia 23510

6. Dates of initiation and, if applicable, completion of the project:

Initiated March, 1974

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

See attached

- (b) Is site a dredged material disposal area ☒, a natural area ☐, or other ☐? If other, please describe.

- (c) Are the sediments at the site unconfined and unprotected ☒ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

N.A.

- (e) Are areas involved in marsh creation regularly ☒, occasionally ☐, seldom ☐, always ☐, inundated? Check one or more.

- (f) Are physical characteristics of sediment mud (silt and clay) ☒, sand ☐, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

Pebble:	0.0	Very coarse sand:	0.0	Silt:	56.8
Granule:	0.0	Coarse sand:	0.0	Clay:	39.9
		Medium sand:	0.2		
		Fine sand:	0.5		
		Very fine sand:	2.3		

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

Organic carbon: 1.90%
Organic nitrogen: 0.17%



BOAT RAMP

STATES - EAST COAST
VIRGINIA

EAGUE INLET TO HIPONGO INLET

Chart Projection
80,000 at Lat. 37°40'

DEPTHS IN FEET
AT LOW WATER

ALL INFORMATION

Height referred to datum of soundings (MLW)

Mean Water	Mean Tide Level	Mean Low Water	Extreme Low Water
at	feet	feet	feet
6	13	00	-25
6	18	00	-25
0	20	00	-25

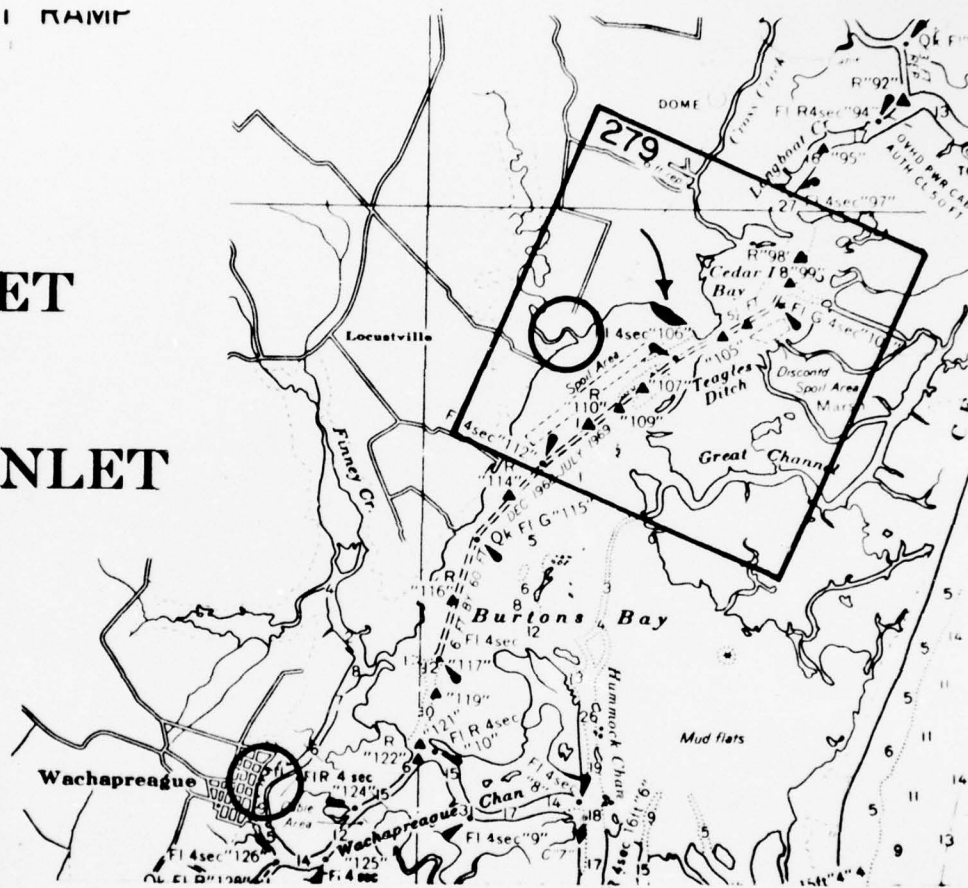


Figure 1. Dredged material disposal site (arrow) at Burton's Bay. Taken from C & GS Chart No. 1221. Scale 1 : 80,000.

AD-A041 464

ENVIRONMENTAL CONCERN INC ST MICHAELS MD

F/G 13/2

RECENT AND PLANNED MARSH ESTABLISHMENT WORK THROUGHOUT THE CONT--ETC(U)

APR 77 E W GARBISCH

DACW39-75-M-4215

UNCLASSIFIED

WES-CR-D-77-3

NL

3 OF 3
AD
A041464

END
DATE
FILMED
7-77

- (h) What is the range (in degrees) of the surface slopes at the site?
 0 - 1°

What is the dominant slope? 0.5°

How were the slopes achieved (e.g. natural or bulldozer grading)? Natural

- (i) What are the major fetch lengths and directions?

1.5 mi (2.8 km) S, SE

- (j) What wind directions prevail Southerly and dominate? Northwesterly
 During what months are the dominant winds encountered?

Winter

- (k) What is the mean lunar tidal amplitude at the site? 4.0'
 Are wind influences on the tide dominant \bar{y} , significant \bar{x} , insignificant \bar{z} ?

- (l) What is the chemical composition of the receiving water at the site (annual salinity range and any known constituents that are present in unusually high concentrations)?

Salinity (0/00): January, 1974, 30.2; June, 1974, 29.9;
 September, 1974, 28.5.

- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally.

None.

- (n) If there were any problems associated with the site preparation, please describe.

N.A.

(o) Please provide recommendations, if any, for site preparation based upon experience. For unconfined dredge material having high percentage (70%) of mud (silt & clay), hydraulic dredge outfall should be placed as close to edge of fast land as is feasible and material should be pumped seaward. Optimum elevations for marsh establishment may best be achieved using retaining structures with sediments of this composition.

- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.

8. Marsh creation description:

(a) What are the principle objectives? To explore mechanisms for effectively establishing Spartina alterniflora within intertidal unconsolidated mud sediments seeding and by planting peat-potted plant stock.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK (Age)	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Spartina alterniflora</u>	Seed	~ MTL	May, 1974
B	<u>S. alterniflora</u>	potted seedlings (3 mos)	> MTL, < MHW	May, 1974
C	<u>S. alterniflora</u>	potted seedlings (2 mos)	> MLW, ≤ MTL	May, June, 1974
D				
E				
F				
G				
H				
I				

- (c) Endemic plant stock was ☒ was not ☐ used. If "was not used," indicate geographic origins of various stock used.

- (d) If plant stocks were purchased, what were the sources?

- (e) What mechanisms were employed for planting?

Seeding: Underwater furrower.

Planting: Pushing plant stock into sediment while (1) floating over area, (2) wading through sediments, (3) walking on sediments with the aid of snow shoes.

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

N.A.

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A			
B			
C			
D			
E			
F			
G			
H			
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

CODE (Provide literature reference in lieu of results if considered desirable)

A Approximately six weeks after seeding, site inspection revealed the total absence of living and/or dead seedlings which may have derived from the sown seed. Additionally, naturally occurring seedlings present in the area at the time of seeding were absent. It was concluded that elevations at the site were too low and the water turbidity too high to readily establish vegetation by seeding. The extent to which the seed germinated is unknown.

B First-year survival of transplants was 93%. Aerial production was 33.9 ± 17.1 g/transplant. As aerial production of this type of plant stock at the time of planting is on the order of 15 g. The observed increase is relatively insignificant. First-year increases in aerial production of this plant stock at other dredged material sites has ranged from 300 to 500 g.

C Survival was on the order of 1% and these were generally located at the highest available elevations of the dredged material. First-year aerial production was very low (9.0 ± 5.2 g/transplant) and winter survival of these plants were expected to be insignificant.

For more detailed information see: Garbisch, E.W., Jr. Woller, P.B., and McCallum, R.J., "Saltmarsh Establishment on Intertidal Dredged Material Areas on the Coast of Virginia", Report submitted to Norfolk District Corps of Engineers, Fort Norfolk, 803 Front Street, Fort Norfolk, Va. 23510. 1975.

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?

See other side of page:

- (c) The problems listed in 9(b) have ☐ have not ☐ been resolved. If the problems have been resolved, please describe the solutions. Attempts to resolve the aforementioned difficulties were not persued at this site.

- (d) Wildlife have ☐ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☐ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?

Not determined.

- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?

- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

Marsh establishment on low fertility dredged materials that are subject to high wave stress and are at marginal elevations should be accomplished with mature nursery stock. Other approaches are not likely to succeed. Recent results indicate that fertilization with Osmocote 19-6-12, 3- to 4- month release fertilizer (40 g/plant site) at the time of planting will markedly accelerate plant establishment.

9b. Poor establishment of introduced vegetation appears to have been related to (a) nutrient deficiencies, (b) absence of optimum elevations at which to introduce plant stock, (c) water turbidity, (d) wave stress, and (e) decrease in elevations resulting from consolidation and erosion of the dredged material. Difficulties were also encountered regarding optimum mechanisms for introduction of plant stock (seed and/or live plants) in the unconsolidated sediments composing the planting area.

No. 15

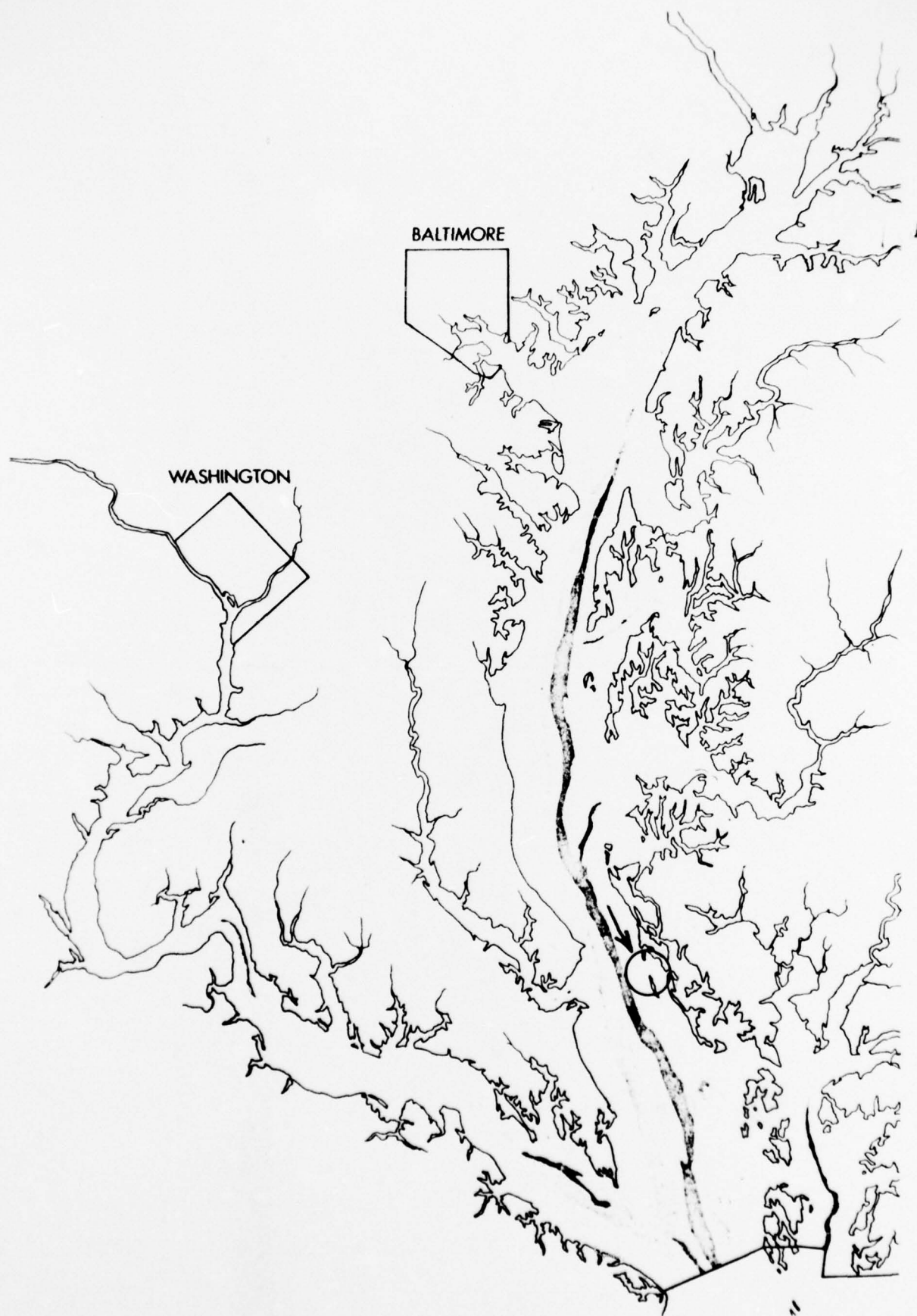
MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Tar Bay (Dredged materials)
2. Institution and its address: Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663
3. Persons directly responsible for the project and their respective office telephone numbers:
Edgar W. Garbisch 301-745-9620
Paul B. Woller
4. Interviewee(s) — person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
Edgar W. Garbisch
Paul B. Woller
5. Agency(ies) funding the project:
Baltimore District Corps of Engineers
Box 1715
Baltimore, Maryland 21203



- (h) What is the range (in degrees) of the surface slopes at the site?
 2 - 3° (below MLW) What is the dominant slope?
 How were the slopes achieved (e.g. natural or bulldozer grading)? Natural. At the dredged material outfall location the sandy sediments mounded to elevations above MHW. The slopes throughout this area were 10° and greater.
- (i) What are the major fetch lengths and directions?
 N - NW: 9 mi (14.4 km) S - SW: 2.5 mi (4.0 km)
- (j) What wind directions prevail SW and dominate? NW
 During what months are the dominant winds encountered?
 November - March
- (k) What is the mean lunar tidal amplitude at the site? 1.3 ft (40 cm)
 Are wind influences on the tide dominant /☐, significant /☒, insignificant /☐?
- (l) What is the chemical composition of the receiving water at the site (annual salinity range and any known constituents that are present in unusually high concentrations)?
 Salinity: 10 - 12 0/00
- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally.
 No.
- (n) If there were any problems associated with the site preparation, please describe.
 N.A.
- (o) Please provide recommendations, if any, for site preparation based upon experience.
- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives? To vegetatively stabilize the intertidal zone of a dredged spoil flat.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Distichlis</u> <u>spicata</u>	Seed	> MHW	March, 1974
B	<u>Spartina</u> <u>patens</u>	Seed	> MHW	March, 1974
C	<u>Spartina</u> <u>alterniflora</u>	Seed	MLW - MHW	March, 1974
D				
E				
F				
G				
H				
I				

- (c) Endemic plant stock was ☐ was not ☒ used. If "was not used," indicate geographic origins of various stock used.

Assateague, Virginia

- (d) If plant stocks were purchased, what were the sources?

- (e) What mechanisms were employed for planting?

All-terrain-vehicle and spike harrow

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

N.A.

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A			
B			
C			
D			
E			
F			
G			
H			
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

CODE	Results (Provide literature references in lieu of results if desirable)
A	The establishment of this species through seeding was unsuccessful.
B	The establishment of this species through seeding was unsuccessful.
C	A relatively uniform stand of seedlings existed throughout the seeded area within 3 mos (June, 1974) after seeding. At this time seedlings at the seawardmost edges of the area were washing out at a relatively high rate. Additionally, it appeared that aerial growth was unusually high relative to root growth, presumably as a result of the inherent fertility of the sediment. When compared to naturally occurring seedlings located in an intertidal sand flat created in 1972 using sand from an inland quarry, statistically significant ($0.05 \leq P$) differences were found with the seedlings from the spoil flat having higher aerial production, greater numbers of culms, and lower percent root values (see below). First-year aerial production (harvested October, 1974) at this site was approximately 1.50 kg/m^2 and not statistically different from aerial production determined for a natural <i>S. alterniflora</i> marsh (1.47 kg/m^2) and a 2-year old <i>S. alterniflora</i> marsh developed from planting peat-potted stock in a remote dredge spoil flat (1.61 kg/m^2). Percent root values determined for first-year growth of seedlings at the Tar Bay Site and of peat-potted plantings at the aforementioned dredge material flat were comparable ($33.6 \pm 7.0\%$ and $34.0 \pm 3.1\%$, respectively) but both values were significantly different from that ($48.6 \pm 6.5\%$) for first-year growth of peat-potted transplants at the intertidal flat created using sand from an inland quarry.

Comparison of growth of *Spartina alterniflora* seedlings during the period of April through June, 1974 at two sites^a.

Site ^b	Production ^c (g/seedling)				
	Aerial	Root	Total	% Root	No. Culms
Tar Bay	0.9 ± 0.4	0.7 ± 0.3	1.6 ± 0.6	42.6 ± 5.7	5.9 ± 2.3
Hambleton Island	0.6 ± 0.1	0.6 ± 0.1	1.2 ± 0.2	50.0 ± 4.6	2.0 ± 1.3

Results of student's t-test

*	ns	ns	**	***
a. Seedlings derived from seed planted March, 1974 at Tar Bar Site and naturally occurring at the Hambleton Island Site. Tabulated values are means of ten samples.				
b. Tar Bay Site is intertidal mud area created in 1972 from dredged material; Hambleton Island Site is intertidal sand area created in 1974 using sand from an inland quarry.				
c. Dry weight.				

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?

The unsuccessful establishment of D. spicata and S. patens above MHW is attributed to seeds washing out due to unstable sediment slopes.

- (c) The problems listed in 9(b) have ☐ have not ☒ been resolved. If the problems have been resolved, please describe the solutions. Mounded tidal sediment having unstable slopes should be graded to slopes of 2 - 4°.

- (d) Wildlife have ☐ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☒ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?

- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?

- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

No. 16

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Slaughter Creek (dredged material)
2. Institution and its address: Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663
3. Persons directly responsible for the project and their respective office telephone numbers:
Edgar W. Garbisch 301-745-9620
Paul B. Woller
4. Interviewee(s) — person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
Edgar W. Garbisch
Paul B. Woller
5. Agency(ies) funding the project:
Baltimore District Corps of Engineers
Box 1715
Baltimore, Maryland 21203

6. Dates of initiation and, if applicable, completion of the project:

Initiated: April, 1974

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

U.S. C & GS Chart No. 77 38° 29' Lat 76° 17' Long See attached

- (b) Is site a dredged material disposal area [X], a natural area [], or other []? If other, please describe.

- (c) Are the sediments at the site unconfined and unprotected ☒ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

N.A.

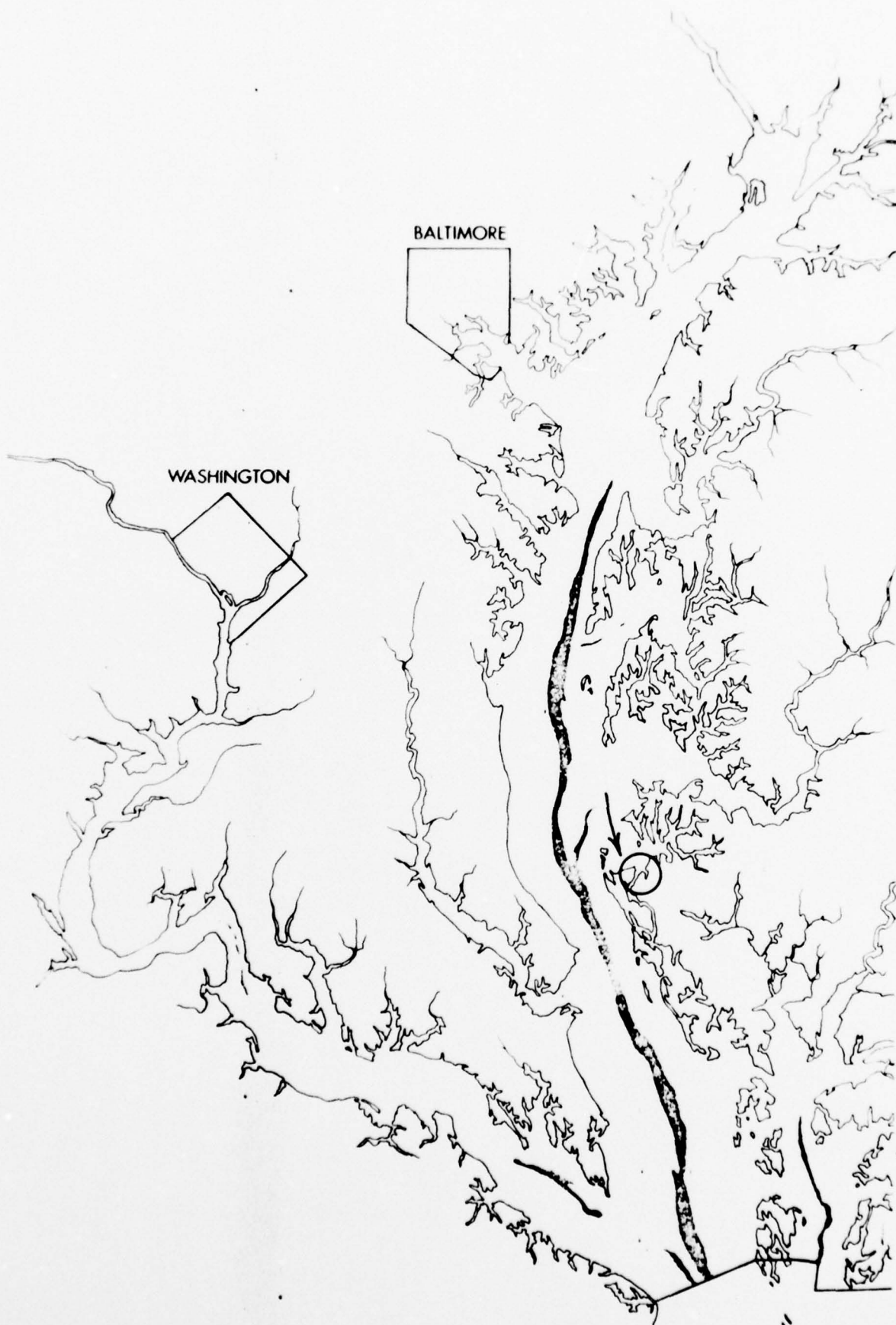
- (e) Are areas involved in marsh creation regularly \bar{X} , occasionally \bar{J} , seldom \bar{I} , always \bar{F} , inundated? Check one or more.

- (f) Are physical characteristics of sediment mud (silt and clay) ☐, sand ☐, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available. A B

		A		B	
		Very Fine Sand	0.9	0.5	
Pebble	0.5	Coarse Sand	4.3	4.5	Silt 37.0
Granule	1.1	Medium Sand	8.7	13.7	Clay 6.1
		Fine Sand	21.4	9.6	
		Very Fine Sand	19.3	13.3	

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

	A	B
Organic carbon:	0.069	0.700
Organic nitrogen:	0.026	0.080



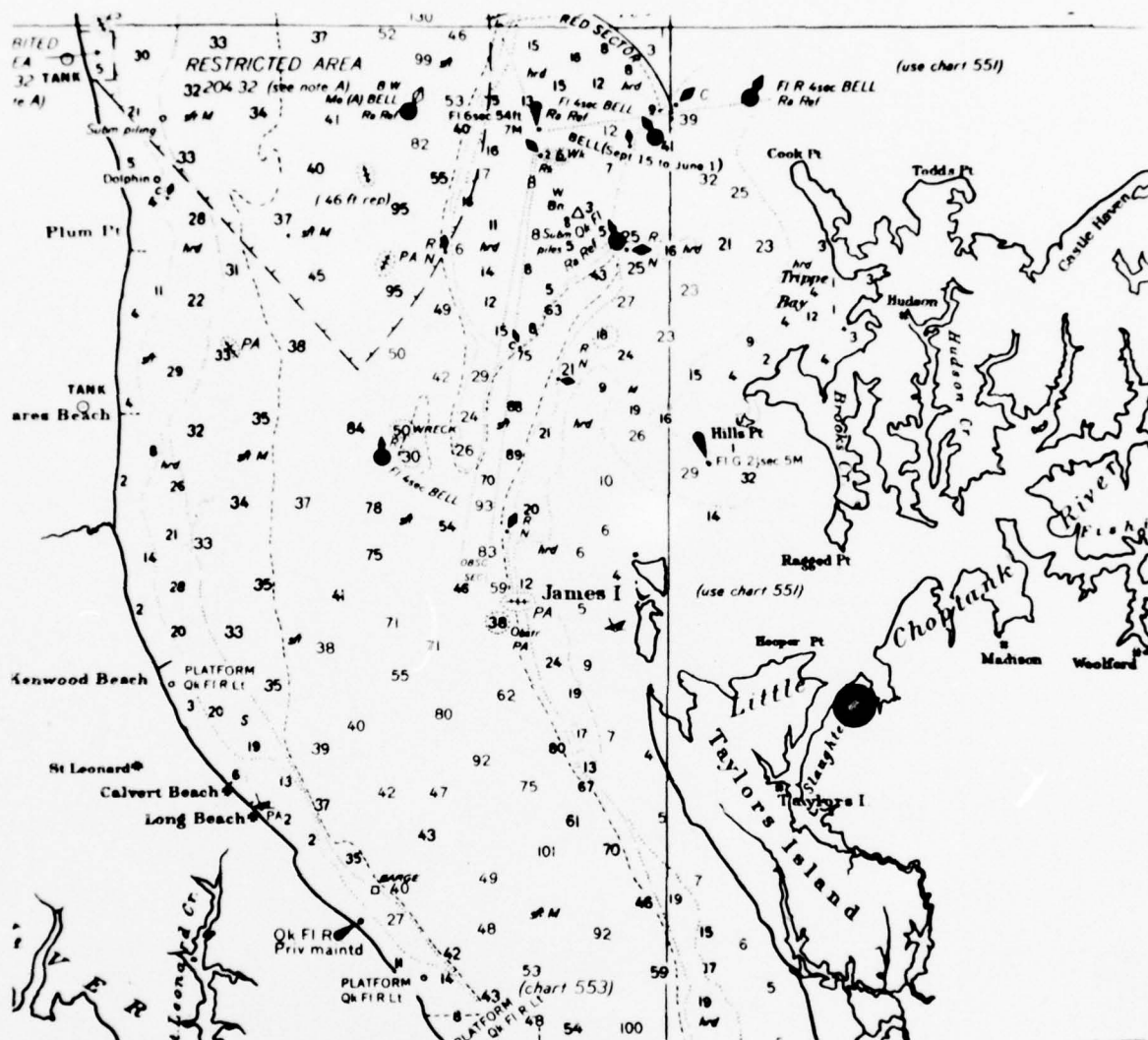


Figure 4. Section of C & GS Chart No. 77 showing the dredged material disposal site (solid circle) in Slaughter Creek near Hooper Pt. The scale is 1:197,250. Note the extensive fetch across the Chesapeake Bay northwest of the site.

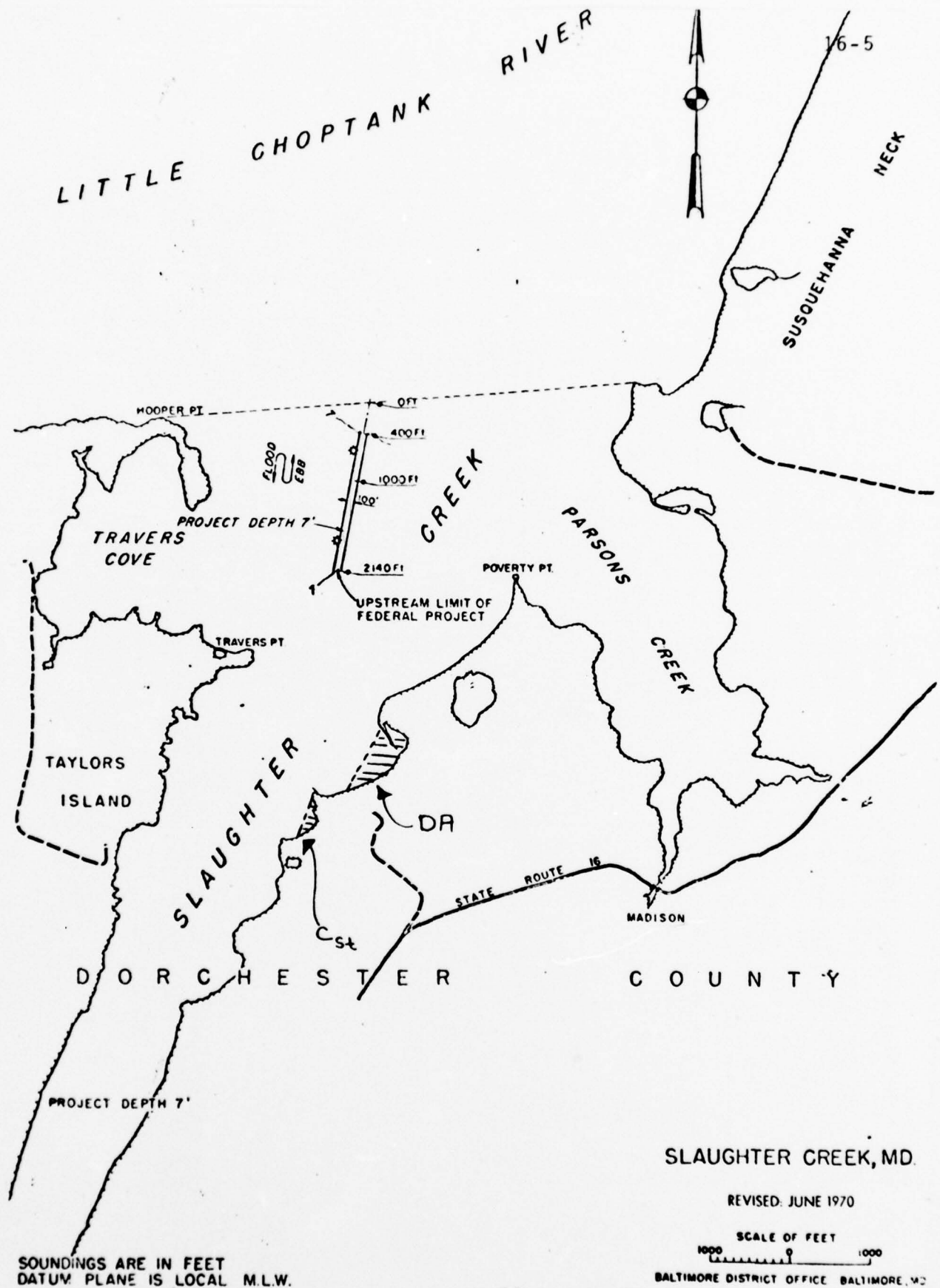


Figure 5. Vicinity map of the Slaughter Creek Dredged Materials Site showing the locations of the dredged materials disposal area (DA) and the natural subtidal comparison area (C_{st}) for macrobenthos sampling.

- (h) What is the range (in degrees) of the surface slopes at the site?
 $< 1^0 - 2^0$ What is the dominant slope? 1^0
 How were the slopes achieved (e.g. natural or bulldozer grading)? Natural and machine graded
- (i) What are the major fetch lengths and directions?
 22 mi (41 km), NW; 0.5 mi (0.8 km) W
- (j) What wind directions prevail S, SW and dominate? N, NW
 During what months are the dominant winds encountered?
 November - March
- (k) What is the mean lunar tidal amplitude at the site? 1.2 ft (37 cm)
 Are wind influences on the tide dominant \bar{X} , significant \bar{X} , insignificant \bar{X} ?
- (l) What is the chemical composition of the receiving water at the site
 (annual salinity range and any known constituents that are present in unusually high concentrations)?
 Salinity: 8 - 12 0/00
- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally.
 Some machine grading required.
- (n) If there were any problems associated with the site preparation, please describe.
 No
- (o) Please provide recommendations, if any, for site preparation based upon experience. For unconfined or partially confined (alongshore) deposition of hydraulically dredged material having a high percentage (> 50%) of fine and large sand sized particles outfall should be regularly re-positioned to minimize need for subsequent machine grading to achieve appropriate elevations and slopes for marsh establishment
- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives? To explore (a) the feasibility of creating salt marshland on dredged materials in an area subject to severe winter wave stress and (b) the extent to which the approach serves as a mechanism for shoreline erosion control.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK (Age)	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Ammophila breviligulata</u>	sprig	MHW	April, 1974
B	<u>Ammophila arenaria</u>	sprig	MHW	April, 1974
C	<u>Distichlis spicata</u>	potted seedlings (10 wks)	MHW	June, 1974
D	<u>Spartina patens</u>	sprig	MHW	April, 1974
E	<u>Spartina patens</u>	potted seedlings (10 wks)	MHW	June, 1974
F	<u>Spartina cynosuroides</u>	potted seedlings (12 wks)	MTL - MHW	June, 1974
G	<u>Spartina alterniflora</u>	potted seedlings (13 wks)	MLW - MHW	May, June, 1974
H	<u>S. alterniflora</u>	potted seedlings (9 wks)	MLW - MHW	June, 1974
I	<u>S. alterniflora</u>	potted seedlings (13 wks)	MLW - MHW	May, June, 1974

Continued on 4a

- (c) Endemic plant stock was ☐ was not ☒ used. If "was not used," indicate geographic origins of various stock used.
New Jersey, Code A,B,& D stock - Assateague, Virginia all other stock.
- (d) If plant stocks were purchased, what were the sources?
Code A,B,& D stock, Cape May Plant Materials Center, Cape May, New Jersey.
- (e) What mechanisms were employed for planting?
Live plant stock: Shovel, gasoline engine powered auger, pushing plant stock into unconsolidated substrate.
Seed: Vehicle and spike harrow.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK (Age)	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
J	<u>S.</u> <u>alterniflora</u>	potted seedlings (13 wks)	MLW - MHW	June, July, 1974
K	<u>S.</u> <u>alterniflora</u>	potted seedlings (13 wks)	MLW - MHW	June, July, 1974
L	<u>S.</u> <u>alterniflora</u>	potted seedlings (13 wks)	MLW - MHW	July, August, 1974
M	<u>S.</u> <u>alterniflora</u>	potted seedlings (9 wks)	MLW - MHW	July, 1974
N	<u>S.</u> <u>alterniflora</u>	seed	MTL , MHW	April, 1975
O	<u>S.</u> <u>patens</u>	seed	MHW	April, 1975
P	<u>Panicum</u> <u>amarulum</u>	seed	MHW	April, 1975

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
E	Ammonium nitrate Superphosphate (4.5 N/1P)	37g mixture per plant site	Surface application June, July, 1974
I	Ammonium nitrate Superphosphate (4.5 N/1P)	37g mixture per plant site	Surface application June, July, September, '74
J	Ammonium nitrate Superphosphate (4.5 N/1P)	37g mixture per plant site	Surface application July, August, September 1974
L	Ammonium nitrate Superphosphate (4.5 N/1P)	37g mixture per plant site	Surface application August, 1974
N	Slow release (Scotts, 34-5-5)	5 lb/1,500 ft ²	Surface application April, 1975
O	Slow release (Scotts, 34-5-5)	5 lb/1,500 ft ²	Surface application April, 1975
P	Slow release (Scotts, 34-5-5)	5 lb/1,500 ft ²	Surface application April, 1975

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A-M	See: Garbisch, E.W., Jr., and Woller, P.B., "Marsh Development on Dredged Materials at Slaughter Creek, Maryland", report submitted to Baltimore District Corps of Engineers, P.O. Box 1715, Baltimore, Maryland 21203. December, 1975.
N	Good germinations was observed to have occurred within three weeks of seeding and by mid-June a uniform stand of 4-6 inch high seedlings was present. Shortly thereafter elevation changes were such that from 2 to 6 inches of sediment was deposited in the area and buried approximately 80% of the seedlings. Those that survived did not become well-established.
O,P	Seed germination was low, emergent seedlings developed poorly, and high fatalities resulted as a result of additional sediment being deposited in the seeded area.

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?

Portions of area not being available for planting at optimum time led to late planting dates and low degree of vegetative establishment at end of growing season. Fertilization of transplants in low permeability substrates too soon after planting led to initial growth retardation.

- (c) The problems listed in 9(b) have ☒ have not ☒ been resolved.

If the problems have been resolved, please describe the solutions.

Had been determined that slow release fertilizer applied at time of planting aids plant establishment without initial growth retardation experienced with fast release fertilizer. Coordination of work is essential between dredging and habitat development contractors.

- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☒ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?

- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?

- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

Of the large number of factors which influenced first-year planting at this site, that regarding time of planting was found to be least easily manipulated and, unlike nutrient deficiencies, could not be compensated for to achieve maximum vegetative establishment. For sites that receive high wave stress particularly during the winter months, plant stock should be introduced as early in the growing season as is feasible under the environmental conditions which prevail at the site. Thus, the intended planting time should be prepared and ready to receive plant stock commensurate with a planting timetable based on these factors.

No. 17

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Snow's Cut
2. Institution and its address:
Soils Department
North Carolina University
Raleigh, North Carolina 27607
3. Persons directly responsible for the project and their respective office telephone numbers:
E.D. Seneca 919-737-2129
S.W. Broome 919-737-2657
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
E.D. Seneca
S.W. Broome
5. Agency(ies) funding the project:
Coastal Engineering Research Center
U.S. Army, Corps of Engineers (funded)
Sea Grant
North Carolina Coastal Research Program

6. Dates of initiation and, if applicable, completion of the project:

March, 1971 - Continuing

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

34° 07' N 77° 56' W

- (b) Is site a dredged material disposal area ☒, a natural area ☐, or other ☐? If other, please describe.

- (c) Are the sediments at the site unconfined and unprotected ☒ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

Unprotected in 1971

Confined as of 1973 by a dike

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

Earthen dike in 1973.

- (e) Are areas involved in marsh creation regularly ☐, occasionally ☐, seldom ☐, always ☐, inundated? Check one or more.

N.A.

- (f) Are physical characteristics of sediment mud (silt and clay) ☐, sand ☐, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

Sand: 96%

Clay: 3%

Silt: 1%

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen, phosphorus, potassium, organic carbon, etc.)

Ca 25-50 g/m² org. carbon to a depth of 12 cm.

Ph=3.7, Soluble salts=1.00 mmho/cc.

P= 93kg/ha, Mn= 28.0 kg/ha.

Ca= 1.35 meq/100cc, Mg= 0.31 meq/100cc.

K= 0.09 meq/100cc, Na= 1.10 meq/100cc.

Vol wt (g/cc) = 1.25

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Spartina alterniflora</u>	sprigs	MLW - MHW +1	March, April, May, June, July, 1971
B	<u>S. alterniflora</u>	seeds	MLW - MHW +1	March, April, May, June, 1971, 1972
C	<u>S. alterniflora</u>	seedlings	MTL	May, 1972, 1973
D				
E				
F				
G				
H				
I				

- (c) Endemic plant stock was ☒ was not ☐ used. If "was not used," indicate geographic origins of various stock used.

- (d) If plant stocks were purchased, what were the sources?

N.A.

- (e) What mechanisms were employed for planting?

hand planting, sprigs and seedlings
rototiller, seeds

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A			
B			
C			
D			
E			
F			
G			
H			
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	Woodhouse, W.W., Jr., E.D. Seneca, and S.W. Broome. 1974. Propagation of <u>Spartina alterniflora</u> for substrate stabilization and salt marsh development. Coastal Engineering Research Center U.S. Army, Corps of Engineers Technical Memorandum. No. 46. 155p.
B	Same as A + Broome, S.W., W.W. Woodhouse, Jr., and E.D. Seneca. 1974. Propagation of Smooth Cordgrass, <u>Spartina</u> ... North Carolina. Chesapeake Sci. 15:214-221.
C	Seneca E.D. 1974. Germination and Seedling Response of Atlantic and Gulf Coasts populations of <u>Spartina alterniflora</u> . Amer. J. Bot. 61:947-956.
D	
E	
F	
G	
H	
I	

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?
- (c) The problems listed in 9(b) have ☒ have not ☐ been resolved. If the problems have been resolved, please describe the solutions.
- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☒ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?
- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?
- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

No. 18

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Beaufort
2. Institution and its address: Soils Department
North Carolina University
Raleigh, North Carolina 27607
3. Persons directly responsible for the project and their respective office telephone numbers:
E.D. Seneca 919-737-2129
S.W. Broome 919-737-2657
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
E.D. Seneca
S.W. Broome
5. Agency(ies) funding the project:
Coastal Engineering Research Center
U.S. Army, Corps of Engineers (funded)
Sea Grant
North Carolina Coastal Research Program

6. Dates of initiation and, if applicable, completion of the project:

April, 1972 - Continuing

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

- (b) Is site a dredged material disposal area ☒, a natural area ☐, or other ☐? If other, please describe.

- (c) Are the sediments at the site unconfined and unprotected ☒ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

Unprotected in late 1971 and early 1972 when spoiled upon.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

N.A.

- (e) Are areas involved in marsh creation regularly ☐, occasionally ☐, seldom ☐, always ☐, inundated? Check one or more.

N.A.

- (f) Are physical characteristics of sediment mud (silt and clay) ☐, sand ☐, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

Sand: 97.6%

Silt: 0.7%

Clay: 1.7%

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

PH= 8.4, soluble salts= 2.75 mmho/cc.

P= 75 kg/ha, Mn= 4.8 kg/ha.

Ca= 39.0 meq/100cc, Na= 4.80 meq/100cc.

Vol wt (g/cc)= 1.40

Organic matter= 0.8%

- (h) What is the range (in degrees) of the surface slopes at the site?
 Ca. 2% What is the dominant slope?
 How were the slopes achieved (e.g. natural or bulldozer grading)? Natural
- (i) What are the major fetch lengths and directions?
 0.1 - 0.1 km
- (j) What wind directions prevail NE, NW and dominate?
 During what months are the dominant winds encountered?
 fall and winter
- (k) What is the mean lunar tidal amplitude at the site? 0.9m
 Are wind influences on the tide dominant / $\bar{\square}$ /, significant / $\bar{\square}$ /, insignificant / $\bar{\chi}$ /?
- (l) What is the chemical composition of the receiving water at the site (annual salinity range and any known constituents that are present in unusually high concentrations)?
 20 - 25 ppt salinity
- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally.
 N.A.
- (n) If there were any problems associated with the site preparation, please describe.
 N.A.
- (o) Please provide recommendations, if any, for site preparation based upon experience.
 Characteristics at site were ideal.
- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.
 See publications

8. Marsh creation description:

- (a) What are the principle objectives?
 Determine the feasibility of field scale seeding of Spartina alterniflora. Establish a S. alterniflora nursery area.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Spartina alterniflora</u>	seeds	MLW - MHW	April, June, 1972
B	<u>S. alterniflora</u>	sprigs	MTL - MHW	April, 1972
C				
D				
E				
F				
G				
H				
I				

- (c) Endemic plant stock was \sqrt{x} was not \sqrt{y} used. If "was not used," indicate geographic origins of various stock used.

- (d) If plant stocks were purchased, what were the sources?
N.A.

- (e) What mechanisms were employed for planting?
Farm tractor drawn spike-toothed harrow and cultivators to disturb site - hand seeding at rate of 100 viable seeds per square meter

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A	P concentrated super-phosphate N ammonium sulfate	0 kg ha ⁻¹	split application June, July, 1972
B	P concentrated super-phosphate N ammonium sulfate	0P 224kg ha ⁻¹ N	split application June, July, 1972
C	P concentrated super-phosphate N ammonium sulfate	49kg ha ⁻¹ P 224kg ha ⁻¹ N	split application June, July, 1972
D			
E			
F			
G			
H			
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

See TM - 46, p139, 142 (TABLE 42)

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	Woodhouse, W.W., Jr., E.D. Seneca, and S.W. Broome. 1974. Propagation of <u>Spartina alterniflora</u> for Substrate Stabilization and Salt Marsh Development. Coastal Engineering Research Center, U.S. Army, Corps of Engineers Technical Memorandum 46. 155p.
B	
C	
D	
E	
F	
G	
H	
I	

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?
- (c) The problems listed in 9(b) have ☒ have not ☐ been resolved. If the problems have been resolved, please describe the solutions.
- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☒ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?
- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?
- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

No. 19

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: South Island
2. Institution and its address:
Soils Department
North Carolina University
Raleigh, North Carolina 27607
3. Persons directly responsible for the project and their respective office telephone numbers:
E.D. Seneca 919-737-2129
S.W. Broome 919-737-2657
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
E.D. Seneca
S.W. Broome
5. Agency(ies) funding the project:
Coastal Engineering Research Center
U.S. Army, Corps of Engineers (funded)
Sea Grant
North Carolina Coastal Research Center

6. Dates of initiation and, if applicable, completion of the project:

April, 1973 - continuing

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

Just south of New Drew Inlet

- (b) Is site a dredged material disposal area ☐, a natural area ☒, or other ☐? If other, please describe.

- (c) Are the sediments at the site unconfined and unprotected ☒ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

N.A.

- (e) Are areas involved in marsh creation regularly ☐, occasionally ☐, seldom ☐, always ☐, inundated? Check one or more.

N.A.

- (f) Are physical characteristics of sediment mud (silt and clay) ☐, sand ☒, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

Sand: 98%

Silt: 0.5%

Clay: 1.5%

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

PH= 8.8, soluble salts= 2.0 mm ha/cc.

P= 33 kg/ha, Mn=3.6 kg/ha.

Ca= 21.5 meq/100cc, Mg= 1.85 meq/100cc.

K= 0.17 meq/100cc, Na= 5.63 meq/100cc.

- (h) What is the range (in degrees) of the surface slopes at the site?
 < 1% What is the dominant slope?
 How were the slopes achieved (e.g. natural or
 bulldozer grading)? Natural
- (i) What are the major fetch lengths and directions?
 5 - 15 km, S-W-NE
- (j) What wind directions prevail NE & SW and dominate?
 During what months are the dominant winds encountered?
 NE fall and winter; SW summer.
- (k) What is the mean lunar tidal amplitude at the site? .6 - .8m
 Are wind influences on the tide dominant \bar{X} , significant \bar{X} ,
 insignificant \bar{X} ?
- (l) What is the chemical composition of the receiving water at the site
 (annual salinity range and any known constituents that are present in
 unusually high concentrations)?
 Ca. 35ppt salinity
- (m) Were there any site preparation requirements (e.g., grading to specific
 elevations)? Please specify generally.
 N.A.
- (n) If there were any problems associated with the site preparation,
 please describe.
 N.A.
- (o) Please provide recommendations, if any, for site preparation based upon
 experience.
 N.A.
- (p) Please provide any additional information and comments that you feel
 might be helpful for future site selections and preparations.
 Salinity built up to 45ppt at times.

8. Marsh creation description:

- (a) What are the principle objectives?(TM-46, p16,69) To determine the
 feasibility of large scale seeding (5ha). To establish marsh from seed in
 an exposed site. To determine the effect of fertilization on seedling growth.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Spartina alterniflora</u>	seed	MTL \pm .3m	April, May, 1973
B				
C				
D				
E				
F				
G				
H				
I				

- (c) Endemic plant stock was ☒ was not ☐ used. If "was not used," indicate geographic origins of various stock used.
Oregon Inlet, North Carolina

- (d) If plant stocks were purchased, what were the sources?

N.A.

- (e) What mechanisms were employed for planting?
2-wheel garden tractor with cultivator. Area was cultivated-seeded at a rate of 100 viable seeds per meter, by hand - cultivated again.

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A	P concentrated super-phosphate N ammonium sulfate	0 kg ha ⁻¹	split application July, August, 1973
B	same as A	0P 112 kg ha ⁻¹ N	same as A
C	same as A	0P 224 kg ha ⁻¹ N	same as A
D	same as A	0P 448 kg ha ⁻¹ N	same as A
E	same as A	49 kg ha ⁻¹ P, 0N	same as A
F	same as A	49 kg ha ⁻¹ P 112 kg ha ⁻¹ N	same as A
G	same as A	49 kg ha ⁻¹ P 224 kg ha ⁻¹ N	same as A
H	same as A	49 kg ha ⁻¹ P 448 kg ha ⁻¹ N	same as A
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

See TM-46, p 143, TABLE 43

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	Woodhouse, W.W., Jr., E.D. Seneca, and S.W. Broome. 1974. Propagation of <u>Spartina alterniflora</u> for Substrate Stabilization and Salt Marsh Development. Coastal Engineering Research Center, U.S. Army, Corps of Engineers Technical Memorandum, 46. 155p.
B	
C	
D	
E	
F	
G	
H	
I	

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?

Salinity buildup at site probably reduced early seedling growth.

- (c) The problems listed in 9(b) have ☐ have not ☒ been resolved. If the problems have been resolved, please describe the solutions.

- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☐ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?

Shorebirds

- (e) Insect problems are ☒ are not ☐ significant. If significant, what are the problems and how were they resolved?

- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.
Seed during expected storm-free periods, during relatively mild weather in late April through May at this latitude.

No. 20

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Pine Knoll Shores, North Carolina
2. Institution and its address: Department of Soil Science
North Carolina Iniversity
Raleigh, North Carolina 27607
3. Persons directly responsible for the project and their respective office telephone numbers:

W.W. Woodhouse, Jr.	-737-2657
E.D. Seneca	-737-2129
S.W. Broome	-737-2657
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.

S.W. Broome
E.D. Seneca
5. Agency(ies) funding the project:

Coastal Engineering Research Center
U.S. Army, Corps of Engineers
Sea Grant
North Carolina Coastal Research Program
North Carolina Agricultural Experiment Station

6. Dates of initiation and, if applicable, completion of the project:

April, 1974 - Continuing

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

Pine Knoll Shores, North Carolina

- (b) Is site a dredged material disposal area ☒, a natural area ☐, or other ☐? If other, please describe.

- (c) Are the sediments at the site unconfined and unprotected ☒ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

- (e) Are areas involved in marsh creation regularly ☒, occasionally ☐, seldom ☐, always ☐, inundated? Check one or more.

- (f) Are physical characteristics of sediment mud (silt and clay) ☐, sand ☒, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

Sand: 99.5%
Silt: 0.2%
Clay: 0.3%

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen, phosphorus, potassium, organic carbon, etc.)

	P	Ca	Mg	K	Na
	Kg/Ha	Meq/100cc	Meq/100cc	Meq/100cc	Meq/100cc
PH	9.00	9.00	2.00	0.20	5.00

- (h) What is the range (in degrees) of the surface slopes at the site?
 What is the dominant slope?
 How were the slopes achieved (e.g. natural or bulldozer grading)? Natural
- (i) What are the major fetch lengths and directions?
 1.5 mi N; 3 mi NW; 4 mi NE
- (j) What wind directions prevail and dominate?
 During what months are the dominant winds encountered?
 SW Summer - NE Winter
- (k) What is the mean lunar tidal amplitude at the site? 2 - 2.5 ft
 Are wind influences on the tide dominant \bar{J} , significant \bar{X} , insignificant \bar{J} ?
- (l) What is the chemical composition of the receiving water at the site (annual salinity range and any known constituents that are present in unusually high concentrations)?
 Salinity \simeq 20-30%
- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally.
 No
- (n) If there were any problems associated with the site preparation, please describe.
- (o) Please provide recommendations, if any, for site preparation based upon experience.
 N.A.
- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives?
 Stabilize shoreline to protect bulkhead.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Spartina alterniflora</u>	seeds, sprigs, rhizomes, seedlings.	MTL - MHW	April, 1974
B	<u>S. alterniflora</u>	sprigs	MTL - MHW	April, 1974
C				
D				
E				
F				
G				
H				
I				

- (c) Endemic plant stock was ☒ was not ☐ used. If "was not used," indicate geographic origins of various stock used.

- (d) If plant stocks were purchased, what were the sources?

N.A.

- (e) What mechanisms were employed for planting?
Mechanical and hand transplanting

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A			
B	Nitrogen (NH ₄) ₂ SO ₄ Phosphorus (conc. super-phosphate)	300 #/ac/yr 150 #/ac/yr	Subsurface April, 1974 (100N/50P) surface applied April, July, Aug., 1975
C			
D			
E			
F			
G			
H			
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

The project appears to have been successful in stabilizing the shoreline in front of a bulkhead. Accretion of sediments has occurred in some places. A report of the project to date is being prepared by the Coastal Engineering Research Center and will be available in a few months.

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	
B	
C	
D	
E	
F	
G	
H	
I	

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?
Seed, rhizomes, and seedlings produced unsatisfactory results.
- (c) The problems listed in 9(b) have ☒ have not ☐ been resolved.
If the problems have been resolved, please describe the solutions.
Sprigs were used.
- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☒ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?
- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?
- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

No. 21

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Mangrove Transplantation on a Dredge Spoil Island. Seagrass Transplantation into Seawalled Artificial Canals.
2. Institution and its address:
Marco Applied Marine Ecology Station
North Barfield Drive
Marco Island, Florida 33937
3. Persons directly responsible for the project and their respective office telephone numbers:
James C. Kinch (813)394-2795
W. David Key (813)394-2795
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
James C. Kinch
W. David Key
5. Agency(ies) funding the project:
Deltona Corporation, Miami, Florida

6. Dates of initiation and, if applicable, completion of the project:

Mangrove Transplantation 16 May 1972 - November 1974
 Seagrass Transplantation April 1975 - Prob. March 1976

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

- (b) Is site a dredged material disposal area ☒, a natural area ☐, or other ☒? If other, please describe.

- (c) Are the sediments at the site unconfined and unprotected ☒ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☒? If other, please describe.

The spoil island is situated within a bay (see map) but otherwise open to wind and wave action. The canal sediments are susceptible to boat wakes, but otherwise stable.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

N.A.

- (e) Are areas involved in marsh creation regularly ☐, occasionally ☐, seldom ☐, always ☒, inundated? Check one or more.

The spoil island is tidal (majority of area below MWL)

- (f) Are physical characteristics of sediment mud (silt and clay) ☒, sand ☒, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

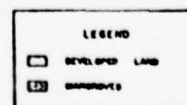
Not analyzed

SITE of
Seagrass
plantings

spoill Island

figure 1.

MARCO ISLAND
& vicinity



- (h) What is the range (in degrees) of the surface slopes at the site? 4-5° on spoil island. What is the dominant slope? 33° in waterways. How were the slopes achieved (e.g. natural or bulldozer grading)? In both cases dragline and/or hydraulic dredge. (Considerable settling has occurred on the island)
- (i) What are the major fetch lengths and directions? Spoil island is 900' NW-SE x 400' NE-SW. NA in seagrass work.
- (j) What wind directions prevail E-NE and dominate? During what months are the dominant winds encountered? March - September
- (k) What is the mean lunar tidal amplitude at the site? 2.3' Are wind influences on the tide dominant ☐, significant ☒, insignificant ☐?
- (l) What is the chemical composition of the receiving water at the site (annual salinity range and any known constituents that are present in unusually high concentrations)? 32-39 o/oo - no unusual constituents at either site.
- (m) Were there any site preparation requirements (e.g., grading to specific elevations)? Please specify generally. None
- (n) If there were any problems associated with the site preparation, please describe. The spoil island was found to settle below the mean water mark after about one year. This spreading increased tidal exposure of plants.
- (o) Please provide recommendations, if any, for site preparation based upon experience. Use of a coffer dam or premanent dike to maintain elevation or selection of a more stable substrate. Sea grass transplants should be shielded from excessive turbulence and should be securely anchored.
- (p) Please provide any additional information and comments that you feel might be helpful for future site selections and preparations. Partial shading of young mangrove transplants could be profitable in yield of plants. Protection from wave action is essential for any success. Anchoring sea grass by tying plants to construction tie rods has proven generally successful and prior treatment with the rooting hormone Napthalene acetic acid could aid in establishment.
8. Marsh creation description:
- (a) What are the principle objectives? In the efforts with mangrove transplanting, we at MAMES wished to develop the capacity to transplant moderately large numbers of trees on to a spoil site. It is hoped that this can be a useful technique to minimize the affects (PTO)

of development in natural areas on the coastal zone. It was determined that the efforts are feasible provided elevation remains stable above mean water. The sea grass work is oriented toward introducing a new productive community in artificial canals.

In the sea grass work the introduction of a potentially important community into the canal berm is an attempt to enhance the artificial canal habitat.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age), etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Rhizophora</u> (2130)	2-3' ht. young trees	MHW to +1	May 72 - March 73
B	<u>Avicennia</u> (15)	3-5' ht.	MHW to +1	May 73
C	<u>Rhizophora</u> (332)	2-8' ht.	MHW to +1	May 73
D				
E				
F	<u>Thalassia</u> (597)	Sprigs	MLW to -3	April 75
G				
H				
I				

() = number planted

- (c) Endemic plant stock was ☒ was not ☐ used. If "was not used," indicate geographic origins of various stock used.

- (d) If plant stocks were purchased, what were the sources?

N.A.

- (e) What mechanisms were employed for planting? Hand plantings in all cases

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A	Pelletized Commercial 6:6:6	100 gms/tree (total 94 trees)	12/72 - Introduced in small holes drilled at base of tree upon planting
B			
C			
D			
E			
F			
G			
H			
I			

9. Marsh creation results: 2477 introduced. 389 as of 11/74 and 5/75.

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).
No conclusive results as yet on seagrass. No black mangrove remained. Several small plots monitored for growth results compared with marked undisturbed trees. Results indicate that transplants exhibit about half growth of natural area trees. (see table).

NATURAL

Date	Total Number	Increment	
		Mean (mm)	Range (mm)
11 June 1973	51	10.63	4-35
20 September 1973	47	32.06	5-100
3 December 1973	51	23.31	0-101
3 June 1974	42	30.43	7-123
19 November 1974	32	136.23	22-292

Average increment growth (all plants)

June 1974	25.08 mm
November 1974	41.03 mm

TRANSPLANT

Date	Total Number	Increment	
		Mean (mm)	Range (mm)
11 June 1973	155	8.16	2-32
20 September 1973	122	13.24	4-41
3 December 1973	92	7.71	0-45
3 June 1974	59	13.86	0-42
19 November 1974	4	84.11	46-171

Average increment growth (all plants)

June 1974	10.36 mm
November 1974	10.98 mm

Complete discussion in: Efforts in Marine Revegetation in Artificial Habitats. Kinch, James C. 1975.

Proceeding of the Second Annual Conference of Coastal Revegetation in Florida. [In press]

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	
B	
C	
D	
E	
F	
G	
H	
I	

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?

previously indicated

- (c) The problems listed in 9(b) have ☐ have not ☒ been resolved. If the problems have been resolved, please describe the solutions.

- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☒ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?

- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?

(Some problem w/ boring isopod (Sphaeroma) in mangrove work, not evaluated in study however).

- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

No. 22

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name:
 - A. Bay Bridge Approach (Grant Ave. Overpass, Oakland)
 - B. Faber Tract (East Palo Alto, CA)
2. Institution and its address:
 - C. Anza Pacifica (Burlingame, CA)
 - D. Alameda Creek Channel (Newark, CA)

San Jose State University
San Jose, CA 95192
3. Persons directly responsible for the project and their respective office telephone numbers:

Dr. H.T. Harvey (408)277-3008
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.

H.T. Harvey
5. Agency(ies) funding the project:

California State Hiway Division (Project A)
Personal - San Jose State University (Project B)
California State Attn. General's Office (Project C)
Corps of Engineers (Project D)

6. Dates of initiation and, if applicable, completion of the project:

Project A	1969-70	completion 1971
Project B	1971	on going
Project C	1974	on going
Project D	1974	on going

7. Site description

(a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

(b) Is site a dredged material disposal area ☒, a natural area ☐, or other ☐? If other, please describe.

(c) Are the sediments at the site unconfined and unprotected ☐ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

Project A - open
 B - protected
 C - semiprotected
 D - open

(d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

Project B - earthendike

(e) Are areas involved in marsh creation regularly ☒, occasionally ☐, seldom ☐, always ☐, inundated? Check one or more.

(f) Are physical characteristics of sediment mud (silt and clay) ☒, sand ☐, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

(g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

not determined

- (h) What is the range (in degrees) of the surface slopes at the site?
5°

What is the dominant slope?

How were the slopes achieved (e.g. natural or bulldozer grading)?

Project A - bulldozer; Project B - natural sediment flow;
C - bulldozer; D - dredge

- (i) What are the major fetch lengths and directions?

not determined

- (j) What wind directions prevail NW wind and dominate?
During what months are the dominant winds encountered?

- (k) What is the mean lunar tidal amplitude at the site?
Are wind influences on the tide dominant / /, significant / /,
insignificant / /?

- (l) What is the chemical composition of the receiving water at the site
(annual salinity range and any known constituents that are present in
unusually high concentrations)?

in process

- (m) Were there any site preparation requirements (e.g., grading to specific
elevations)? Please specify generally.

Yes, between about +2' above MLLW and 2' above MHW.

- (n) If there were any problems associated with the site preparation,
please describe.

Project D too high had to be lower with clamshell dredge.

- (o) Please provide recommendations, if any, for site preparation based upon
experience.

Know critical elevation at site for first preparation.

- (p) Please provide any additional information and comments that you feel
might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives?

Establish cordgrass as rapidly as possible.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age) etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Spartina foliosa</u>	Plugs,	+7' to +8'*	Feb. '70
B	<u>Spartina foliosa</u>	Plugs	+6 to 9'	July '71
C	<u>Spartina foliosa</u>	Plugs, potted plants & seeds	+4 to +9'	May '74
D	<u>Spartina foliosa</u>	Plugs, potted plants & seeds	+2 to +4'	May '74
E	<u>Salicornia pacifica</u>	plugs, seeds	+7' to +8'	Feb. '70
F	<u>Distichlis spicata</u>	Plugs, seeds	+7 to 8'	Feb. '70
G	<u>Grindelia humilis</u>	seeds	+7 to +8	Feb. '70
H				
I				

* MLLW datum

- (c) Endemic plant stock was ☒ was not ☐ used. If "was not used," indicate geographic origins of various stock used.

- (d) If plant stocks were purchased, what were the sources?

- (e) What mechanisms were employed for planting?

Hand planting, holes dug by shovel.

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A			
B			
C			
D			
E			
F			
G			
H			
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	No success with seeds. After 1 year only 10% survival of transplants.
B	After 1 year 60% survival with reduced growth at upper elevations and complete mortality at highest elevations.
C	After 1 year 60% survival of plugs with mid elevation survival and best growth. Suspected two ecotypes not substantiated.
D	After 1 year 40% survival of plugs and over 200 seedlings from 4 liters of seed. Seedlings survived only at elevations above lower cordgrass plugs.
E	After one year 70% survival of transplants, no success with seeds.
F	After one year 20% survival of plugs. No success with seeds
G	Over one hundred plants established along bank from est. 1000 seeds.
H	
I	

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?

Too small plugs (3 inc. dia.) had lower survival rate than larger plugs. Planting during severe winds.

- (c) The problems listed in 9(b) have ☒ have not ☐ been resolved. If the problems have been resolved, please describe the solutions.

Use 4-5 in. dia. plugs. Plant during calm days.

- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☐ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?

(Coots consumed new cordgrass shoots.)

- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?

- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

No. 23

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name: Establishment of Intertidal Marsh Plants on Dredge Material Substrate - Alameda Creek, California
2. Institution and its address:
San Francisco Bay Marine Research Center, Inc.
Mailing Address: 8 Middle Road
Lafayette, CA 94549
3. Persons directly responsible for the project and their respective office telephone numbers:
C.L. Newcombe, Kenneth W. Floyd: (415)232-5100
H.T. Harvey: (408)277-3008
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
5. Agency(ies) funding the project:

Army Corps of Engineers, San Francisco District Office

6. Dates of initiation and, if applicable, completion of the project:

Initiated in 1974 to be completed in December 1975.

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.

See Attached Map.

- (b) Is site a dredged material disposal area ☐, a natural area ☐, or other ☐? If other, please describe.

Project 1: Dredged material was placed in intertidal zone of Alameda Creek in May 1974.

- (c) Are the sediments at the site unconfined and unprotected ☐ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.

Project 1: Unprotected from tidal waters of Alameda Creek.

- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

- (e) Are areas involved in marsh creation regularly ☐, occasionally ☐, seldom ☐, always ☐, inundated? Check one or more.

Project 1: Regular inundation during tidal cycle.

- (f) Are physical characteristics of sediment mud (silt and clay) ☐, sand ☐, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.

Mostly fine mud.

- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)

Given in Alameda reports to ACE for Project 1.

- (h) What is the range (in degrees) of the surface slopes at the site?
 about 1' in 10' What is the dominant slope?
 How were the slopes achieved (e.g. natural or
 bulldozer grading)?
- (i) What are the major fetch lengths and directions?
 about 100 feet NS direction.
- (j) What wind directions prevail NW and dominate?
 During what months are the dominant winds encountered?
- (k) What is the mean lunar tidal amplitude at the site?
 Are wind influences on the tide dominant /☐, significant /☐,
 insignificant /☐?
 Project 1: about 6 feet Dec-April
- (l) What is the chemical composition of the receiving water at the site
 (annual salinity range and any known constituents that are present in
 unusually high concentrations)? Salinity range 15 to 28 parts per M,
 depending on spring freshets, chemical components given in SERL
 Reports/UCB Sanitary Engineering Department Studies.
- (m) Were there any site preparation requirements (e.g., grading to specific
 elevations)? Please specify generally.
- (n) If there were any problems associated with the site preparation,
 please describe.
- (o) Please provide recommendations, if any, for site preparation based upon
 experience.
- (p) Please provide any additional information and comments that you feel
 might be helpful for future site selections and preparations.

8. Marsh creation description:

- (a) What are the principle objectives? Objectives of sponsors have been to provide
 a plant cover for aesthetic purposes, for measuring productivity, and for
 restoring the marsh to its original condition as a coastal habitat for the
 natural communities and for human enjoyment.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age) etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted. Project 1: *Spartina foliosa* and *Salicornia pacifica*. Various types and treated seeds and propagules were used at Alameda Creek at all appropriate levels

TABLE 1

(see MRC 1975 report)

CODE	PLANT SPECIES	PLANT STOCK	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A				
B				
C				
D				
E				
F				
G				
H				
I				

- (c) Endemic plant stock was \sqrt{x} was not \sqrt{y} used. If "was not used," indicate geographic origins of various stock used.

- (d) If plant stocks were purchased, what were the sources? Not purchased, seeds and tumps (plugs) from S.F. Bay Marshes. Seedlings and cuttings grown in MRC nursery.

- (e) What mechanisms were employed for planting?

Only hand work.

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1). Half of about 68 experimental plots were fertilized. (See MRC 1975 report).

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A			
B			
C			
D			
E			
F			
G			
H			
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1). Please refer to 1975 MRC Report* on establishment of intertidal marsh plants.

* A complete report of the 2-year study to be released by ACE in early 1976.

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	
B	
C	
D	
E	
F	
G	
H	
I	

please list references to available published material (on project) not given in Table 3.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?

Settling of freshly deposited dredge material

- (c) The problems listed in 9(b) have ☐ have not ☒ been resolved. If the problems have been resolved, please describe the solutions.

Improved raking in procedure will assure better seed survival.

- (d) Wildlife have ☐ have not ☒ utilized created marsh areas and wildlife management problems do ☐ do not ☒ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?

- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?

- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

Allow time for settling and consolidation of newly deposited dredge material.

Use abundant seed and/or transplant material to compensate for natural mortality.

No. 24

MARSH CREATION RESEARCH
INFORMATION REQUEST

April 1975

INSTRUCTIONS - Please complete this information request as thoroughly as possible. Use "NA" when not applicable and leave blank when the requested information is unknown or not available. Use the backs of the pages if the spaces allotted are insufficient. The plantings to be listed in Table 1 are coded. Please use the same codes in Tables 2 and 3 when describing the fertilization programs and the results of these plantings. For example, if there are two areas of Mangrove seedling transplants at MTL-MHW elevations, one which was fertilized and one which was not, these plantings should be entered twice in Table 1 (Codes A and B). In Table 2, only the fertilized planting should be listed under the appropriate Code. In Table 3 the results from the fertilized and unfertilized plantings should be listed under Codes A and B. Please print or type and return to:

Environmental Concern Inc.
Post Office Box P
St. Michaels, Maryland 21663

1. Project identification name:
San Francisco Bay and Estuary Dredge Disposal Study
Marsh Development Study
2. Institution and its address:
San Francisco District Army Corps of Engineers
100 McAllister Street
San Francisco, California 94102
3. Persons directly responsible for the project and their respective office telephone numbers:
Paul L. Knutson - Project Manager for the San Francisco District (415)556-7348
Dr. Curtis L. Newcombe - Project Director for the San Francisco Bay
Marine Research Center (415)232-5100
4. Interviewee(s) -- person(s) completing information request and person(s) planning on participating in personal interview. If different, so indicate.
5. Agency(ies) funding the project:

U.S. Army Corps of Engineers

6. Dates of initiation and, if applicable, completion of the project:

Initiated in October 1973

To be completed in February 1976

7. Site description

- (a) Site location (C & GS Chart No. and coordinates). Please attach section of indicated chart with site boundaries penciled in, if possible.
See enclosure one
- (b) Is site a dredged material disposal area ☒, a natural area ☐, or other ☐? If other, please describe.
- (c) Are the sediments at the site unconfined and unprotected ☒ or protected ☐, confined ☐, by a breakwater ☐, a dike ☐, a groin ☐, or other ☐? If other, please describe.
- (d) If sediments at the site are either protected or confined, what structures and materials were used (e.g., earthen dike, riprap breakwater, wooden groins).

N.A.
- (e) Are areas involved in marsh creation regularly ☒, occasionally ☐, seldom ☐, always ☐, inundated? Check one or more.
- (f) Are physical characteristics of sediment mud (silt and clay) ☒, sand ☐, pebbles ☐? If more than one check, double check dominant. Please provide percentages if available.
- (g) What is the sediment chemical composition (Kjeldahl nitrogen, nitrate and ammonia nitrogen phosphorus, potassium, organic carbon, etc.)
See enclosure two (Alameda Creek Unconfined Dredge Material)

- (h) What is the range (in degrees) of the surface slopes at the site?
 five to seven degrees What is the dominant slope? about five degrees
 How were the slopes achieved (e.g. natural or
 bulldozer grading)?
 Excavation by clamshell dredge
- (i) What are the major fetch lengths and directions?
 Negligible (Location of area approximately 1000 yards upstream
 Alameda Creek)
- (j) What wind directions prevail westerly and dominate?
 During what months are the dominant winds encountered?
 May-August
- (k) What is the mean lunar tidal amplitude at the site? eight feet
 Are wind influences on the tide dominant ☐, significant ☐,
 insignificant ☒?
- (l) What is the chemical composition of the receiving water at the site
 (annual salinity range and any known constituents that are present in
 unusually high concentrations)?
 Inclosure Three (South Bay)
- (m) Were there any site preparation requirements (e.g., grading to specific
 elevations)? Please specify generally. Planting area for Spartina foliosa
 excavated to 6.0 to 9.0 feet mean lower low water datum. Planting area for
Salicornia pacifica excavated to 8.0 to 11.0 feet mean lower low water datum.
 (Mean higher high water at sites is approximately 8.0 feet)
- (n) If there were any problems associated with the site preparation,
 please describe.
 Site had to be excavated from a floating dredge as land equipment could
 not be efficiently used in the area.
- (o) Please provide recommendations, if any, for site preparation based upon
 experience.
- (p) Please provide any additional information and comments that you feel
 might be helpful for future site selections and preparations.
 Plant Salicornia pacifica at elevations from MHW (mean high water) to the
 EHT (estimated highest tide).
 Plant Spartina foliosa at elevations from MTL (mean tide level) to MHW.

8. Marsh creation description:

- (a) What are the principle objectives? Appraise the relative success of various
 starter types of marsh plants upon a dredged material substrate.

- (b) Please fill in the following table of plant species used, plant stock used (seeds, sprigs, rhizomes, seedlings, (potted, bare root, age) etc.), elevations planted (e.g., MLW-MTL, MTL-MHW, MHW to +1, where MTL = mean tide level and MHW to +1 = MHW to one foot above MHW), month-year planted.

TABLE 1

CODE	PLANT SPECIES	PLANT STOCK	ELEVATIONS PLANTED	MONTH-YEAR PLANTED
A	<u>Spartina foliosa</u>	Sprigs	MTL-MHW	May 1974
B	<u>Spartina foliosa</u>	Seeds	MTL-MHW	May 1974
C	<u>Spartina foliosa</u>	Seedlings Potted Six Months	MTL-MHW	May 1974
D	<u>Spartina foliosa</u>	Cuttings Potted Six Months	MTL-MHW	May 1974
E	<u>Salicornia pacifica</u>	Cuttings Unrooted	MHW-+1	May 1974
F	<u>Salicornia pacifica</u>	Cuttings Potted Six Months	MHW-+1	May 1974
G	<u>Salicornia pacifica</u>	Seedlings Potted Six Months	MHW-+1	May 1974
H				
I				

- (c) Endemic plant stock was ☒ was not ☐ used. If "was not used," indicate geographic origins of various stock used.

- (d) If plant stocks were purchased, what were the sources?
San Francisco Bay Marine Research Center

- (e) What mechanisms were employed for planting?

- (f) If fertilization programs were adopted, please complete Table 2 (code refers to Table 1).

See Questionnaire completed by Dr. Curtis Newcombe

TABLE 2

CODE	FERTILIZER DESCRIPTION	APPLICATION RATE	WHEN AND HOW SURFACE OR SUBSURFACE) APPLIED
A			
B			
C			
D			
E			
F			
G			
H			
I			

9. Marsh creation results:

- (a) Please provide any qualitative or quantitative results (e.g., fatality percentages, biomass determination results, etc.) in the following table (code refers to Table 1).

TABLE 3

CODE	RESULTS (Provide literature references in lieu of results if considered desirable)
A	Summary of Results See Inclosure Four
B	San Francisco Bay and Estuary Dredge Disposal Study Appendix K - Marshland Development Study Published by the San Francisco District Corps of Engineers
C	
D	
E	
F	
G	
H	
I	

please list references to available published material (on project) not given in Table 3.

Knutson, Paul L. 1975. The use of dredged material for the development of intertidal marshlands. In Record of OCEAN 75 the combined meeting of 1975 IEEE Conference on Engineering in the Ocean Environment and Eleventh Annual Meeting of MTS.

- (b) What problems (chemical, physical, biological, and/or mechanical) have been encountered with regard to vegetative establishment?

Effective use of mechanical equipment limited by the nature of the substrate.

- (c) The problems listed in 9(b) have ☐ have not ☒ been resolved. If the problems have been resolved, please describe the solutions.

- (d) Wildlife have ☒ have not ☐ utilized created marsh areas and wildlife management problems do ☐ do not ☐ exist. If management problems do exist, what wildlife create the problems and are the problems now rectified and if so by what means?

- (e) Insect problems are ☐ are not ☒ significant. If significant, what are the problems and how were they resolved?

- (f) Please provide any additional information and comments that you feel might be useful to ensure the success of a marsh creation project at a similar site.

MUD

SALT EVAPORATORS

Mt Eden

FLOOD CONTROL CHANNEL
LEVEE

Alameda

LEVEE

SALT

EVAPORATORS

MUD

REDWOOD POINT, CALIF.
SW/4 Hayward 15' Quadrangle
N3730-W12207.5/7.5
1959; Photorevised 1968 & 1973

CITY
BOUNDARY

B221

24-8

LEV

North

Derrick

Creek

LEVEE

ALAMEDA

SALT EVA

Turk
Island

HAYWARD
FREMONT

CITY
CITY

DITCH

BDY
BDY

NEWARK, CALIF.
SE/4 Hayward 15' Quadrangle
N3730-W12200/7.5
1959; Photorevised 1968 & 1973

INCLOSURE ONE

COMPARISON OF MARSH SOILS AND DREDGED SEDIMENTS

PARAMETER	UNITS	Marsh Soils	Dredged Channels Sediments	Alameda Creek Channel Sediments	Alameda Creek Confined Dredged Material-Pond 3	Alameda Creek Unconfined Dredged Material
Moisture Content	% Dry Wt.	139.0 ^{1/}	97.5 ^{2/}	93.4 ^{3/}	53.3 ^{4/}	97.4 ^{5/}
Mean		-	66-124	63-112	31-119	79-117
Range						
Grain Size	%					
Sand		15-20 ^{1/}	19.4 ^{2/}	5 ^{3/}	5 ^{4/}	-
Silt/Clay		80-85	79.6	95	95	-
Salinity	% Dry Wt.					
Mean		Cordgrass	2.2-3.9 ^{6/}	-	5.3 ^{4/}	2.7 ^{5/}
Range		Pickleweed	3.5-8.1 ^{7/}	-	3.5-10.1	1.8-3.7
Cations						
Calcium (Ca)	PPM Dry Wt.	62.0 ^{8/}	-	-	493 ^{4/}	2833.0 ^{5/}
Magnesium (Mg)	PPM Dry Wt.	14.3	-	-	1284	2370.8
Sodium (Na)	PPM Dry Wt.	-	-	-	1519	-
Potassium (K)	PPM Dry Wt.	-	-	-	-	1521.0
Anions						
Phosphate (P)	PPM Dry Wt.	35.1 ^{8/}	-	-	0.22 ^{4/}	74.5 ^{5/}
Nitrate (N)	PPM Dry Wt.	1.0	-	-	-	4.7
Chloride (Cl)	PPT Dry Wt.	-	-	-	26.8	14.6
Metals						
Iron (Fe)	PPT Dry Wt.	.18 ^{9/}	-	-	42.1 ^{4/}	.75 ^{5/}
Zinc (Zn)	PPM Dry Wt.	3.2	108.1 ^{9/}	109.7 ^{3/}	89.5	2.9
Lead (Pb)	PPM Dry Wt.	16.0	35.5	9.7	18.4	2.0
Mercury (Hg)	PPM Dry Wt.	.1	.65	.5	.5	.13
Copper (Cu)	PPM Dry Wt.	-	41.6	-	35.1	.9

1/ Pestrong, 1969 (Spartina zone)

2/ DDS - Appendix J

3/ Inclosure 6 - Report of Tests for Pollutants in Bottom Sediment Samples - Alameda Creek Flood Control Project, April 1972 (N = 10).

4/ Inclosure 7 - Alameda Creek Sediment Analysis November 1975, Depth 25-30 cm (N = 10).

5/ Inclosure 2 - Marsh Studies - Newcomb et al 1975

6/ Purer, 1942

7/ Mall, 1969

8/ Inclosure 1 - Marsh Studies - Mason 1973.

9/ DDS - Appendix B

INCLOSURE TWO

SANITARY ENGINEERING RESEARCH LABORATORY
WATER QUALITY DATA

1960-1964

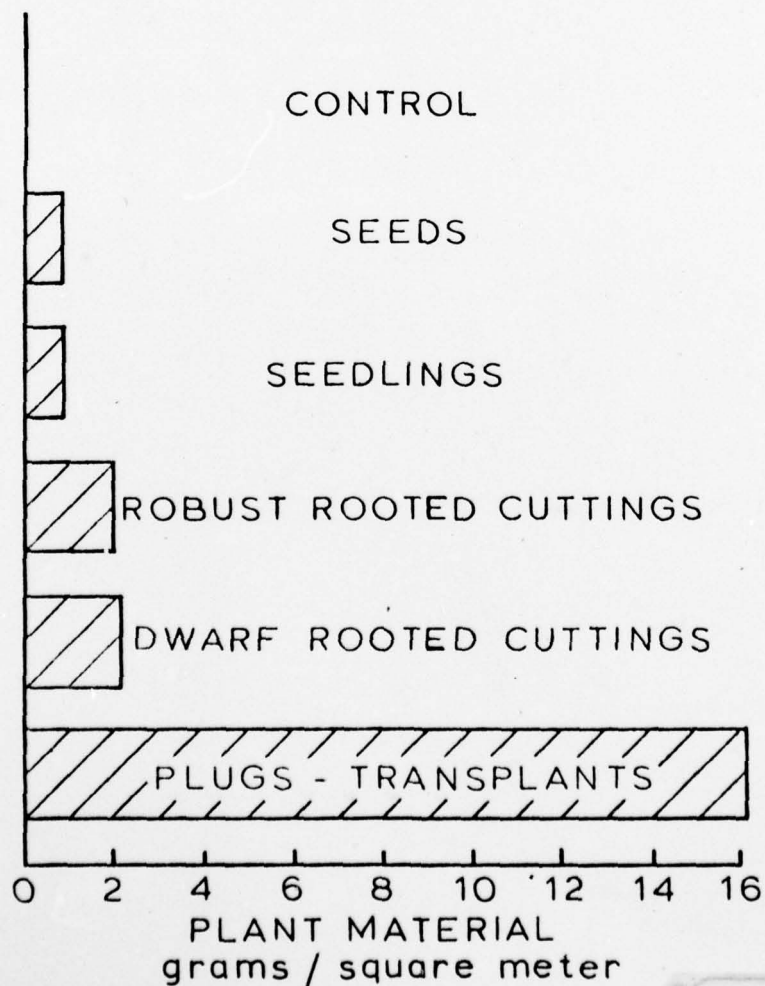
PARAMETER		SOUTH BAY	CENTRAL BAY	SAN PABLO	SUISUN BAY
CHLOROSITY (Cl ⁻ , mg/l)	max	18.5	18.0	16.0	8.5
	min	10.5	15.5	3.5	0.02
	mean	15.0	16.5	10.5	2.5
EST. SALINITY (ppt)	max	32.2	31.4	28.0	14.8
	min	18.1	27.1	5.8	0.04
	mean	26.2	28.9	18.1	4.2
TEMPERATURE (°C)	max	22.5	18.3	19.3	21.3
	min	10.0	10.7	8.3	6.9
	mean	15.5	13.8	14.9	15.0
DIS. OXYGEN (mg/l)	max	8.4	8.3	9.3	10.2
	min	3.3	6.3	6.8	6.6
	mean	6.3	7.3	8.0	8.4
pH (Std. Units)	max	8.1	8.1	7.9	8.0
	min	7.5	7.5	7.2	7.4
	mean	7.8	7.9	7.7	7.7
SUS. SLDS (mg/l)	max	110	48	245	112
	min	12	6	13	34
	mean	42	18	45	65
TRANSPARENCY (feet)	max	6.2	9.0	3.5	1.5
	min	0.5	1.0	0.5	0.5
	mean	2.7	4.6	1.6	0.9

SOURCE: Pearson, E. A., P. N. Storrs, and R. E. Selleck. 1971. A Comprehensive Study of San Francisco Bay. Final Report, Summary, Conclusions and Recommendations, Calif. State Water Resources Control Bd., Publ. 42.

INCLOSURE THREE

CORDGRASS
COMPARISON OF STARTER TYPES
AFTER ONE GROWING SEASON
(OCTOBER 1974)

STARTER TYPE	# PLANTS/ SQUARE METER	COEFFICIENT OF VARIATION	DRY WEIGHT GRAMS/PLANT	COEFFICIENT OF VARIATION
Control	0.02	254	--	--
Seeding	1.29	90	0.72	60
Seedlings	0.54	32		
Robust Rooted Cuttings	0.28	81	7.39	52
Dwarf Rooted Cuttings	0.70	23	3.23	67
Plugs	0.80	18	20.16	74

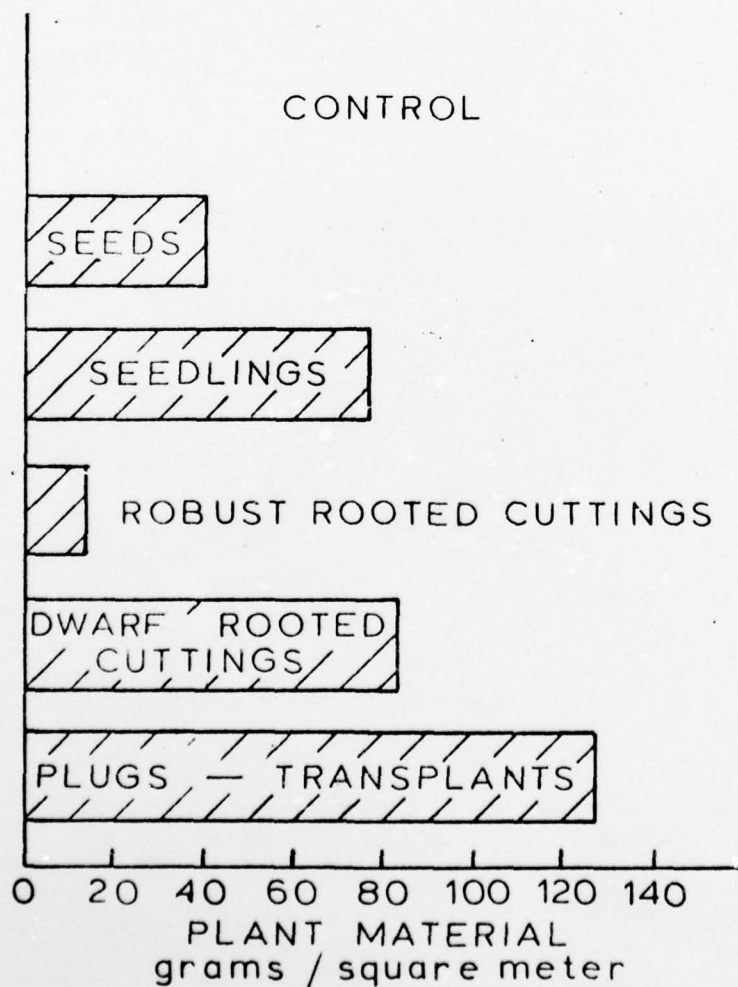


B225

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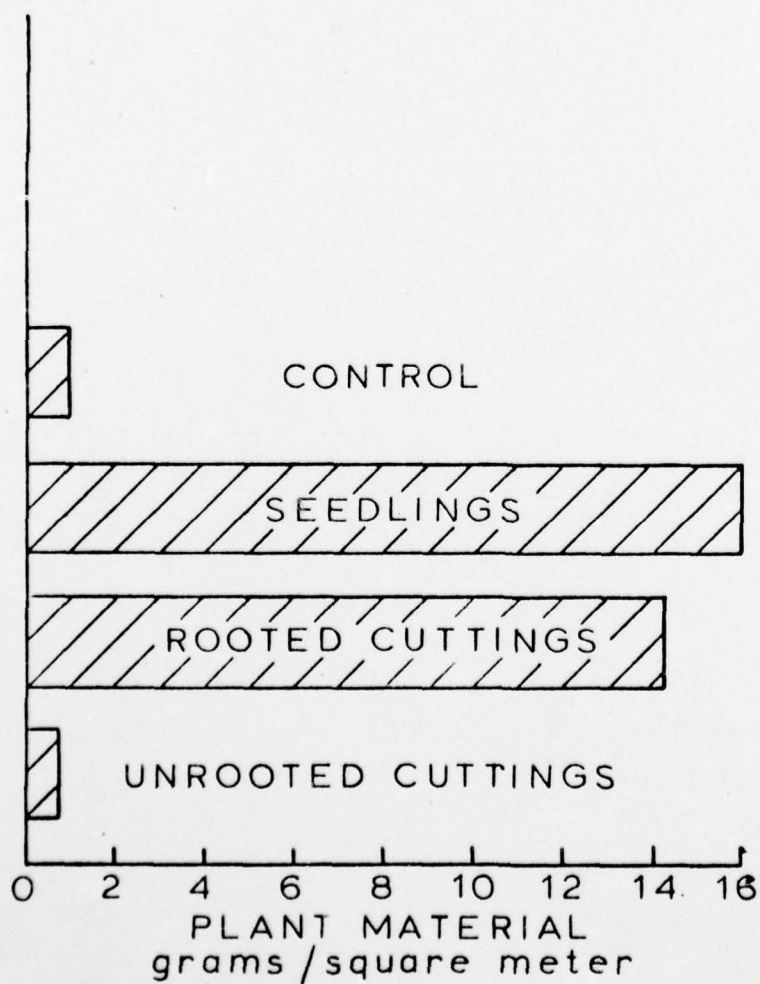
CORDGRASS
COMPARISON OF STARTER TYPES
AFTER TWO GROWING SEASONS
(OCTOBER 1975)

STARTER TYPE	# PLANTS/ SQUARE METER	COEFFICIENT OF VARIATION	DRY WEIGHT GRAMS/PLANT	COEFFICIENT OF VARIATION
Control	0.20	165	--	--
Seeding	4.31	53	9.43	32
Seedlings	5.62	61	13.87	57
Robust Rooted Cuttings	1.07	125	12.07	70
Dwarf Rooted Cuttings	7.84	48	10.54	62
Plugs	8.95	48	14.17	46



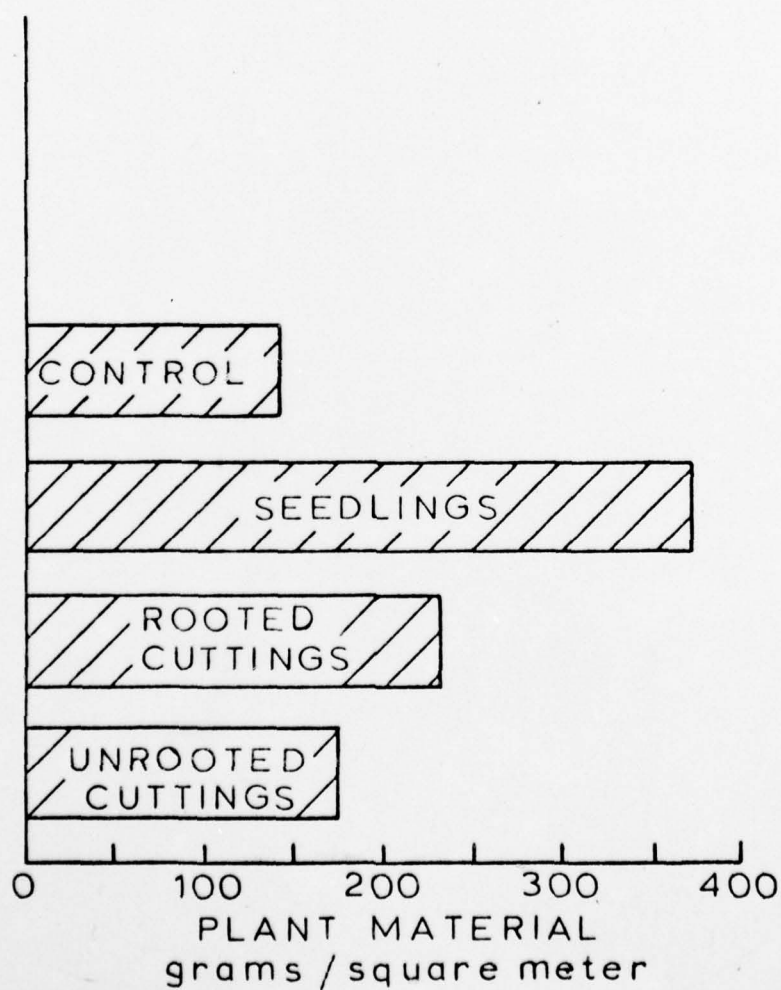
PICKLEWEED
COMPARISON OF STARTER TYPES
AFTER ONE GROWING SEASON
(OCTOBER 1974)

STARTER TYPE	# PLANTS/ SQUARE METER	COEFFICIENT OF VARIATION	DRY WEIGHT GRAMS/PLANT	COEFFICIENT OF VARIATION
Control	0.04	200	25.62	8
Seedlings	0.69	28	23.24	64
Rooted Cuttings	0.55	69	26.25	80
Unrooted Cuttings	0.03	181	27.36	57



PICKLEWEED
COMPARISON OF STARTER TYPES
AFTER TWO GROWING SEASONS
OCTOBER (1975)

STARTER TYPE	# PLANTS/ SQUARE METER	COEFFICIENT OF VARIATION	DRY WEIGHT GRAMS/PLANT	COEFFICIENT OF VARIATION
Control	2.39	52	59.05	75
Seedlings	3.35	66	111.27	49
Rooted Cuttings	1.85	79	125.12	60
Unrooted Cuttings	3.03	76	57.77	82



In accordance with ER 70-2-3, paragraph 6c(1)(b), dated 15 February 1973, a facsimile catalog card in Library of Congress format is reproduced below.

Garbisch, E W

Recent and planned marsh establishment work throughout the contiguous United States -- a survey and basic guidelines, by E. W. Garbisch, Jr., Environmental Concern, Inc., St. Michaels, Md. Vicksburg, U. S. Army Engineer Waterways Experiment Station, 1977.

1 v. (various pagings) illus. 27 cm. (U.S. Waterways Experiment Station. Contract report D-77-3)

Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C.; monitored by Environmental Effects Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss., under Purchase Order No. DACW39-75-M-4215 (DMRP Work Unit 4A25).

Includes bibliography.

1. Marshes. I. Environmental Concern, Inc. II. U. S. Army. Corps of Engineers. (Series: U. S. Waterways Experiment Station, Vicksburg, Miss. Contract report D-77-3)

TA7.W34c no.D-77-3